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WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

THREE MILE & SULFUR DRAW WATERSHED PROJECT

CULBERSON and HUDSPETH COUNTIES, TEXAS

December 1975

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ADDENDUM
THREE-MILE AND SULFUR DRAW WATERSHED, TEXAS

INTRODUCTION

This addendum is based on the Water Resource Council's "Principles and Standards for Planning Water and Related Resources," which became effective October 30, 1973. It is prepared to be consistent with the requirements of the Water Resource Council's Procedure No. 1 for the phase-in of the Principles and Standards. The information presented is:

Part I - Benefits to Cost Comparison

An evaluation of the selected plan using current normalized prices, current construction costs, and the current interest rate.

JAN - 3 1977

Part II - Four Account Displays

Evaluated effects of the selected plan are displayed under separate accounts for (1) National Economic Development, (2) Environmental Quality, (3) Regional Development, and (4) Social Well-Being. The displays are consistent with the intent of the Principles and Standards.

CATALOGING - PREP.

Part III - Abbreviated Environmental Quality Plan

An environmental quality plan, consistent with the intent of the Principles and Standards, but which is abridged in detail, has been developed by an interdisciplinary team. It is an alternative plan to the selected plan and is formulated to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. This plan was formulated from information and data obtained during the investigative and analysis phases of project planning. Formulation began with the inventory and recognition of the watershed problems and needs. Desired environmental effects, as translated from the problems and needs, provided a basis for examining appropriate water and land resource use and management opportunities. Opportunities that emphasized contributions to the component needs were selected and are shown as plan elements of the abbreviated environmental quality plan. The cost of $3,660,000 for its installation is a preliminary estimate.

Implementation of features of this environmental quality plan would require acceptance by the local people. Adequate legal authorities do exist for installation; however, funding for all plan elements is presently not available through existing legislative authorities.

PART I

This addendum shows the project cost, benefits, and benefit-cost ratio based on a 6-1/8 percent interest rate, current normalized prices and the 1975 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1.	Project costs are	$170,730
2.	Project benefits are	173,950
3.	The project benefit-cost ratio is	2.5:1.0
4.	The project benefit-cost ratio excluding secondary benefits is	2.0:1.0

PART II

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects[1]
Beneficial effects:	
A. The value to users of increased outputs of goods and services	
1. Flood prevention	$140,720
Total beneficial effects	$140,720

Components	Measures of effects[1]
Adverse effects:	
A. The value of resources required for a plan	
1. Two floodwater retarding structures and floodwater diversion	
a. Project Installation	$59,710
b. Project administration	8,020
c. Operation and maintenance	3,000
Total adverse effects	$70,730
Net beneficial effects	$69,990

A2

1/ Average annual

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Selected Plan
REGIONAL DEVELOPMENT ACCOUNT

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects 1/ Region 2/	Rest of Nation
A. Income:		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region.		
a. Flood prevention	$140,720	
b. Secondary	33,230	
Total beneficial effects	$173,950	

Components	Measures of effects 1/ Region 2/	Rest of Nation
A. Income:		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Two floodwater retarding structures and floodwater diversion		
Project installation (structural measures)	$ 2,610	$57,100
Project administration	120	7,900
Operation and maintenance	3,000	
Total adverse effects	$ 5,730	$65,000
Net beneficial effects	$168,220	-$65,000

A3

45,214

1/ Average annual

2/ Upper Rio Grande Valley-Texas, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

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Selected Plan

REGIONAL DEVELOPMENT ACCOUNT (continued-2)

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects	
	Region 1/	Rest of Nation
B. Employment:		
Beneficial effects:		
1. Increase in the number and types of jobs.		
a. Agricultural employment.	20 permanent semi-skilled jobs.	---
b. Employment for project construction.	43 man-years of semi-skilled employment during the installation period (5 years).	---
Total beneficial effects	20 permanent semi-skilled jobs.	---
	43 man-years of semi-skilled employment over the installation period (5 years).	---

Components	Measures of effects	
	Region 1/	Rest of Nation
B. Employment:		
Adverse effects:		
1. Decrease in number and types of jobs.	0	0
Total adverse effects	0	0
Net beneficial effects	20 permanent semi-skilled jobs.	
	43 man-years of semi-skilled employment over the installation period (5 years).	

1/ Upper Rio Grande Valley-Texas, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

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Selected Plan

REGIONAL DEVELOPMENT ACCOUNT (Continued-3)

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects	
	Region 1/	Rest of Nation
C. Population Distribution		
Beneficial effects	Create 20 permanent semi-skilled jobs in a rural area and 43 man-years of semi-skilled employment over the installation period (5 years)	---
Adverse effects	---	---
D. Regional Economic Base and Stability		
Beneficial effects	Create 20 permanent semi-skilled jobs and 43 man-years of semi-skilled employment over the installation period (5 years). Reduce flood hazard on about 13,200 acres of flood plain. Reduce flood hazard to owners and occupants of about 110 homes in Van Horn.	
Adverse effects	---	---

1/ Upper Rio Grande Valley-Texas, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

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Selected Plan

SOCIAL WELL-BEING ACCOUNT

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects
neficial and adverse fects:	
eal Income distribution	1. Create 23 permanent semi-skilled jobs and 43 man-years of semi-skilled employment over the installation period (5 years).
	2. Create regional income benefit distribution of $173,950 benefits by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	5	1
3,000 - 10,000	45	2
More than 10,000	50	97

	3. Local costs of $5,730 annually will be borne by Culberson County and financed by tax revenue. The percentage of contributions to local costs by income classes is not readily available.
Life, health, and safety	1. Provide protection from the 100-year event to 110 houses in Van Horn with population of 2,240 in 1970. Future threats of loss of life and displacements during floods will be eliminated.

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ENVIRONMENTAL QUALITY ACCOUNT

Three-Mile and Sulfur Draw Watershed, Texas

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty.	1. Temporarily inundate 48 acres of rangeland needed for sediment pools below the lowest ungated outlets.
B. Quality considerations of water and land resources.	1. Reduce erosion on 840 acres of irrigated cropland.
	2. Reduce sediment deposition on 385 acres of irrigated cropland.
	3. Suspended sediment concentration carried by runoff water leaving the watershed will be reduced from 5,600 milligrams per liter to 1,600 milligrams per liter.
	4. A maximum initial reduction in average annual runoff of 60 acre-feet is expected from the effects of evaporation from sediment pools of the floodwater retarding structures. This will result in an initial reduction from 2,380 to 2,320 acre-feet, 2.5 percent, in average annual volume of watershed runoff.
C. Biological resources and selected ecosystems.	1. Enhance habitat and food supply for most wildlife species throughout the watershed.

Components	Measures of effects
D. Irreversible or irretrievable commitments.	1. Conversion of 508 acres of rangeland to dams, emergency spillways, and sediment pools, and floodwater diversion.
	2. Materials, labor, equipment, fuel, and capital used in construction, operation, and maintenance will be irreversibly committed.

PART III

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Three-Mile and Sulfur Draw Watershed, Texas

Environmental quality is a major concern that must be considered in planning soil and water conservation projects which involve changes in land use and alterations of existing ecosystems. This plan was developed for the Three-Mile and Sulfur Draw Watershed in an effort to identify conditions which affect quality of the watershed environment and to provide a plan of action to meet environmental quality objectives. Environmental quality objectives of the plan are preservation or enhancement of areas of natural beauty; conservation and development of soil, water, air, and related resources; preservation and augmentation of biological resources and ecosystems; and providing opportunities for water based recreation in the watershed.

Data collected during the course of watershed investigations indicate that the major environmental quality problems are flooding of agricultural and urban properties and needed improvement in grazing land ecosystems. There are no water impoundments in the watershed vicinity providing suitable fish habitat or opportunities for water-based recreation. Flooding causes monetary and property loss, disruption of normal human activity, damage to agricultural land, and depletion of the basic soils resource. Past over use of grassland ecosystems by grazing animals has reduced the quantity and quality of natural vegetation. Ability of the grassland ecosystem to support a livestock industry and

to provide food and cover needs of indigenous wildlife species has been reduced. Soil, water, and related resources have also been adversely affected by deterioration of grassland ecosystems. The nearest large lake is Red Bluff Reservoir located about 100 miles to the northeast near the Texas - New Mexico border.

Three-Mile and Sulfur Draw Watershed is located in the Trans-Pecos area of Texas within the Southern Desertic Basins, Plains and Mountains Land Resource Area. The city of Van Horn is on the southern boundary of the 95,360 acre watershed.

Climatic conditions in the watershed are arid. The average annual precipitation rate is about 10 inches. The area is subject to high intensity rains of short duration with long interim periods of little or no measurable rainfall. The net annual evaporation rate is approximately 75 inches. Temperatures range from a mean maximum in July of 95 degrees Farenheit to a mean minimum of 30 degrees in January. The normal growing season is from about April 1 to November 11.

The watershed is characterized by arid hills and mountains in the extreme northern and western portions and wide nearly level plains or valleys in the southern and eastern portions. The transition zone between these areas is a series of overlapping alluvial fans. Soils have developed from out-wash materials from the mountains and vary from course to fine in texture.

Ground water is the only source of dependable water supply in the watershed and surrounding area. Water from this source is considered to be adequate in quantity and quality for present and future uses.

Cropland in the watershed is confined to the eastern section of the watershed which is nearly level and has necessary irrigation water available from underground sources. The majority of the watershed is presently used as rangeland.

Livestock grazing became a major industry in the watershed in the latter part of the nineteenth century. Early livestock operators had little concept of the fragile nature of desert grassland ecosystems and over grazing of climax forage plants caused a significant change in plant composition. Many of the more palatable plants which provide forage for livestock and wildlife were severely depleted and were replaced by species which have little value as forage.

Component needs for solving problems relating to specific environmental conditions are listed below:

1. Areas of Natural Beauty
    a. Reduce sheet and gully erosion on the uplands.
    b. Maintain a diversity of landscapes.
2. Quality of Water, Land, and Air Resources
    a. Protect the land resource base from deterioration by reducing sheet erosion, gully erosion, flood plain scour, streambank erosion, and sediment deposition.

b. Maintain and enhance productivity of the land resource base.

c. Improve quality of the air by reducing dust derived from rangeland in poor condition and dirt and gravel roads.

d. Prevent damage of residences and associated improvements, roads, and to sources of livelihood of human inhabitants by flooding.

3. Biological Rsources and Ecosystems

a. Create and manage a dependable fish habitat.

b. Provide and manage a refuge for the rare bighorn sheep.

c. Improve the ecosystem of native vegetation patterns of the watershed on land presently used as rangeland.

d. Preserve and enhance the habitat conditions for species of wildlife presently in the watershed by:

(1) Eliminating destruction of habitat.

(2) Providing more dependable food and water sources.

(3) Reducing damage to habitat from flooding, sedimentation, scour, etc.

(4) Developing additional cover for selected species of wildlife.

4. Recreational Resources

a. Improve present game species habitat and food supply to provide adequate game for hunting.

b. Provide impoundments adequate for water-base recreation.

The plan elements for environmental quality consist of management practices, land treatment measures, structural measures, and land acquisition. Cropland treatment measures would include conservation cropping systems (use of diversified crops in rotation and the management of their residues), irrigation water management, irrigation land leveling, irrigation systems, and diversions. Pastureland treatment would consist of planting or seeding adapted species of perennial forage plants and their management for sustained production.

Rangeland would be managed to maintain or improve existing vegetation and reestablish the native plant composition. Treatment measures would include proper grazing use, planned grazing systems and deferred grazing. Also, wells, troughs, and pipelines for additional wildlife water would be installed. Wildlife upland habitat management would also be included as an increment of land treatment to be implemented. Land users would be encouraged and assisted in the application and maintenance of these measures by the local soil and water conservation district with technical assistance from the Soil Conservation Service. Financial assistance, on a cost-share basis, is available through the Rural Environmental Conservation Program administered by the Agricultural Stabilization and Conservation Service. Loans for application of needed soil and water conservation measures are available through the Farmers Home Administration.

Installation of about 55,000 feet of floodwater diversion and two multiple purpose structures with adequate water impoundments for fish

habitat and recreation use would reduce flooding in the city of Van Horn and the agricultural area. These elements would be implemented by the Culberson County Commissioners Court and the governing body of the city of Van Horn.

Improvement of 110 miles of county and private roads would consist of hard surfacing the roads. This element would be in addition to rangeland improvement to reduce dust. Installation of hard surfaced roads would be accomplished by the county government and private land owners and users.

A refuge would be provided for bighorn sheep by acquiring about 10,000 acres of suitable habitat now being used as rangeland. This element would be implemented by local, state, and federal agencies as it involves the acquisition of a large amount of private land.

The estimated installation costs of the elements of the environmental quality plan are as follows:

1. Completion of the application of land treatment measures: $200,000
2. Two multiple-purpose structures $936,200, and about 55,000 feet of floodwater diversion $350,300
3. Improvement of 110 miles of county and private roads: $1,760,000
4. Creation of a 10,000 acre refuge for bighorn sheep: $400,000

Total installation cost of the environmental quality plan is estimated to be $3,646,500.

Environmental effects that would result from installation of the environmental plan are as follows:

1. Areas of Natural Beauty
    a. Enhance the appearance of 25 farms and ranches in the watershed through application and maintenance of land treatment measures.
    b. Maintain diversity of the landscape through preservation and enhancement of the land resource base which sustains this diversity.
    c. Provide greater diversity of landscape by superimposing the embankments and water impoundments of multiple-purpose structures on the arid setting of the watershed.
2. Quality of Water, Land, and Air Resources
    a. Reduce sediment load carried in watershed runoff through reduction of sheet erosion, gully erosion, streambank erosion, and flood plain scour.
    b. Prevent deterioration of the land resource base by providing protection from erosion by installing or applying needed vegetative and mechanical treatment measures.
    c. Maintain and enhance productivity of the land resource base by applying agronomic and vegetative management practices.

d. Reduce flooding on 200 acres of urban land in Van Horn, Texas, and 13,000 acres of agricultural land.

e. Reduce dust and associated pollution of air adjoining vegetation along 110 miles of dirt and gravel surfaced county and private roads.

f. Prevent destruction from watershed runoff of urban and agricultural properties, and source of livelihood for about 15 land users of property in the Wild Horse farming areas.

g. Reduce interruption of use, from floodwater, of the transportation system in the flood-prone areas.

h. Result in initial reduction in average watershed runoff of about 10 percent due to evaporation from water impoundments for fish habitat and recreational use.

3. Biological Resources and Selected Ecological Systems

a. Create fish habitat in the watershed were none presently exists.

b. Establish a 10,000 acre refuge for bighorn sheep.

c. Improve native vegetation composition on areas being used as rangeland.

d. Improve habitat and food supply for some wildlife species such as deer and scaled quail as a result of improvement of native rangeland vegetation composition.

e. Change about 195 acres of poor quality wildlife habitat to fish habitat.

4. Recreational Resources

   a. Opportunities for fishing, which presently are non-existent in the vicinity of the watershed, will be available to area residents.

   b. Provide opportunities for water-based recreation such as boating, waterskiing, and swimming.

   c. Sustain or improve opportunities for deer, scaled quail, and mourning dove hunting.

5. Irreversible or Irretrievable Commitments

   a. Require use of 1,966 acres of rangeland for installation and functioning of the floodwater diversion and proper functioning of multiple-purpose structures.

   b. Require labor, energy, and materials for construction of improvement.

WATERSHED WORK PLAN AGREEMENT

between the

High Point Soil and Water Conservation District
Local Organization

Culberson County Commissioners Court
Local Organization

City of Van Horn
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Texas

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Three-Mile and Sulfur Draw Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Three-Mile and Sulfur Draw Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire, with other than PL-566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost $42,450).

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	18.15	81.85	0 1/

1/ Investigation has disclosed that under present conditions that project measures will not result in the displacement of any person, business or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
2 Floodwater Retarding structures and about 55,000 feet of floodwater diversion	0	100	885,540

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
2 floodwater retarding structures and about 55,000 feet of floodwater diversion	0	100	44,280

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $2,000 and $128,520 respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.

14. No member of or delegate to congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

High Point Soil and Water Conservation District
Local Organization

By M. C. Sibley

Title Chairman

P.O.Box 545, Van Horn, Texas 79855
Address Zip Code

Date April 7, 1976

The signing of this agreement was authorized by a resolution of the governing body of the High Point Soil and Water Conservation District
Local Organization
adopted at a meeting held on April 7, 1976

Jan E Means
Secretary, Local Organization

P. O. Box 387, Van Horn, Texas 79855
Address Zip Code

Date April 12, 1976

Culberson County Commissioners Court
Local Organization

By John Conley

Title County Judge

P.O.Box 927, Van Horn, Texas 79855
Address Zip Code

Date April 12, 1976

The signing of this agreement was authorized by a resolution of the governing body of the Culberson County Commissioners Court
Local Organization
adopted at a meeting held on April 12, 1976

Frances Walker
Secretary, Local Organization

P. O. Box 158, Van Horn, Texas 79855
Address Zip Code

Date April 12, 1976

City of Van Horn
Local Organization

By James B. Nuckols

Title Mayor, City of Van Horn

P. O. Box 1028, Van Horn, Texas 79855
Address Zip Code

Date April 12, 1976

The signing of this agreement was authorized by a resolution of the governing body of the City of Van Horn
Local Organization
adopted at a meeting held on April 12, 1976

Wynell Walker
Secretary, Local Organization

P. O. Box 1028, Van Horn, Texas 79855
Address Zip Code

Date April 12, 1976

Appropriate and careful consideration has been given to the enviormental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

Approved by:

George C. Marlin
State Conservationist

4-26-76
Date

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

THREE-MILE AND SULFUR DRAW WATERSHED

Culberson and Hudspeth Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Prepared By:

High Point Soil and Water Conservation District
(Sponsor)

Culberson County Commissioners Court
(Sponsor)

City of Van Horn
(Sponsor)

With Assistance By:

U.S. Department of Agriculture
Soil Conservation Service

December 1975

WATERSHED WORK PLAN

THREE-MILE AND SULFUR DRAW WATERSHED

December 1975

SUMMARY OF PLAN 1/

The work plan for watershed protection and flood prevention for Three-Mile and Sulfur Draw Watershed has been prepared by the High Point Soil and Water Conservation District, Culberson County Commissioners Court, and the city of Van Horn as sponsoring local organization. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Fish and Wildlife Service, United States Department of the Interior, and the Soil Conservation Service, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources and habitat of the watershed. The Archaeology Research Program, Department of Anthropology, Southern Methodist University, made surveys and evaluations of archaeological resources to be affected by the structural works of improvement proposed in the Plan.

Financial assistance in developing the work plan was provided by the Texas State Soil and Water Conservation Board.

Three-Mile and Sulfur Draw Watershed comprises an area of 149 square miles in portions of Culberson and Hudspeth Counties. It is estimated that 8.7 percent of the watershed is cropland, 0.1 percent is pasture and hayland, 88.7 percent is rangeland, and 2.5 percent is in miscellaneous uses such as the city of Van Horn, public roads, railroads, farmsteads, ranch headquarters, and county airport.

The principal problem within the watershed is one of extensive flooding on portions of the 13,200 acres of flood prone agricultural land, which results in damages to crops, grasses, soils, agricultural properties, and highways. In addition, an existing floodwater diversion above the city of Van Horn and the county airport is not adequate to provide protection from floods in excess of those expected to occur on the average of once every 25 years. The total floodwater, sediment, flood plain erosion, and indirect damages are estimated to average $161,060 annually.

Project objectives are the proper use, treatment, and management of soil and water resources in the watershed; the protection of agricultural and

1/ All information and data in this work plan, except as otherwise noted by reference to source, were collected during watershed planning investigations by the Soil Conservation Service, U.S. Department of Agriculture.

urban flood prone lands and property; and the stimulation of economic development of the area as a result of project installation. The project as formulated will meet these objectives.

Landowners and operators will establish and maintain needed land treatment measures on an additional 5,590 acres of cropland, 20 acres of pastureland, and 20,750 acres of rangeland during a five-year installation period, in addition to the maintenance of those measures already applied. Wildlife upland habitat management will be applied on rangeland which is utilized by both livestock and wildlife to provide needed wildlife habitat and protect the wildlife resource. The installation cost of these land treatment measures is estimated to be $190,300, of which $171,300 will be from funds provided by landowners and operators. An estimated $19,000 of Public Law 46 funds will be needed for technical assistance in planning and applying the additional land treatment.

The structural measures in this work plan are two floodwater retarding structures and 55,000 feet of floodwater diversion to be constructed during a five-year installation period. The total estimated cost of structural measures is $1,102,790, of which the local share is $44,450, and the Public Law 566 share is $1,058,340. The local share of the cost consists of land rights and project administration.

Installation of the project will contribute to the conservation, orderly development, and productive use of the watershed's soil, water, and related resources. Watershed lands will be protected from erosion, and sediment yielded to flood plain areas will be reduced.

The project will provide protection to 13,200 acres of flood prone area within the watershed. Direct benefits will be realized by owners and operators of approximately 15 farms and ranches in the agricultural flood prone area and the owners and occupants of about 110 residential units in Van Horn through the reduction of floodwater, sediment, erosion, and indirect damages.

Additional opportunities for employment will be created effecting a greater potential for increased income to households and demand for services.

A total of 1,781 acres of land will be needed for installation and proper functioning of the floodwater retarding structures and floodwater diversion. The dams and emergency spillways will require 78 acres, sediment pools 68 acres (48 acres below the lowest ungated outlets), floodwater retarding pools 171 acres, and auxiliary borrow areas 86 acres. The floodwater diversion will require a total of 1,378 acres. The diversion will be installed on 382 acres. Flowage easements will be obtained on 996 acres. Of this 996 acres, 346 acres will be above and adjacent to the diversion, and 650 acres will be between station 0+00 and Wild Horse Draw (figure 4a).

Approximately 594 acres will be cleared of all existing woody vegetation for the construction of dams (included are 86 acres for auxiliary borrow areas), emergency spillways, sediment pools below the lowest ungated outlets, and the floodwater diversion. Vegetation, where practical, will be reestablished to protect the soil resource, and species will be used that provide wildlife food and cover. Except for occasional and temporary inundation, the remaining 1,187 acres will not be disturbed.

Average annual damages will be reduced from $161,060 to $12,100 by the proposed project. Average annual benefits accruing to structural measures in the watershed will be $173,950, which includes $140,720 damage reduction benefits and $33,230 secondary benefits. The ratio of total average annual benefits accruing to structural measures ($173,950) to the average annual cost of these measures ($70,730) is 2.5:1.0.

Land treatment measures will be operated and maintained by owners and operators of the land upon which the measures will be applied under agreement with the High Point Soil and Water Conservation District. The Culberson County Commissioners Court will be responsible for operation and maintenance of the two floodwater retarding structures and the floodwater diversion. The annual cost of operation and maintenance of the structural measures is estimated to be $3,000.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

Three-Mile and Sulfur Draw Watershed comprises an area of 95,360 acres (149 square miles) in Culberson and Hudspeth Counties, Texas. The watershed is located within the Trans-Pecos Region of Texas about 120 miles southeast of El Paso, Texas; 190 miles northwest of Big Bend National Park; and 110 miles south of Carlsbad, New Mexico. The city of Van Horn is on the southern boundary of the watershed.

Climatic conditions in the watershed are arid. The average annual precipitation is about 10 inches. Thirty years of records indicate that over 60 percent of this average will fall during the months of July through October. The area is subject to high intensity rains of short duration with long interim periods of very little or no measurable rainfall. Winter and early spring are usually very dry. The net annual evaporation rate for the area is about 75 inches. Temperatures range from a mean maximum in July of 95 degrees Fahrenheit to a mean minimum of 30 degrees in January. The normal growing season is from about April 1 to November 11, or 224 days. 1/

1/ "Climatological Data, Texas Annual Summary," U.S. Department of Commerce National Oceanic and Atmospheric Administration, Environmental Data Service.

Watershed elevations range from 6,519 feet above mean sea level on the northwestern divide in the Sierra Diablo Foothills to approximately 3,690 feet along Wild Horse Draw. The western one-half and the extreme north central part of the watershed is dominated by areas of steep, rugged topography consisting mainly of the Beach Mountains and portions of the Carrizo and Baylor Mountains and the Sierra Diablo Foothills (figure 5). These mountains are fault-block mountains that display flat tops bounded by abrupt or very steeply sloping, prominent scarps characteristic of mesas. Slopes at the base of the mountains are generally less than those at higher elevations. The eastern portion of the watershed is part of a large, regional, north-south trending, intermontane, enclosed basin which has a rather uniform width of about 20 miles and a length in excess of 100 miles. The northern portion of the basin extends into southern New Mexico. The eastern periphery of the watershed is a nearly level, topographically featureless area. Proceeding from east to west, the slope of the land becomes progressively greater until there is an abrupt change at the base of the mountains.

The two principal water courses in the watershed, Three-Mile Draw and Sulfur Draw, originate in the southern portion of the Sierra Diablo Foothills (figure 5). Three-Mile Draw flows in a southeasterly direction between the southern end of the Beach Mountains and the eastern tip of the Carrizo Mountains, then turns toward the northeast and flows on to a broad alluvial plain in the eastern and northeastern part of the watershed known as the Wild Horse farming area. The portion of Wild Horse farming area within the watershed is intensively cultivated and irrigated and lies on the west side of Wild Horse Draw which flows northward into a series of intermittent salt lakes known as Salt Basin. The southern portion of Salt Basin is about 40 miles north of Van Horn. From its origin, Sulfur Draw flows eastward between the northern end of the Beach Mountains and the southern extremity of the Baylor Mountains and then into the Wild Horse farming area. The watershed lies within the Rio Grande Water Resource Area.

All water courses in the watershed are ephemeral, flowing only in response to surface runoff. Stream channels in the mountainous portions of the watershed are well defined and unmodified by man. Deposition of sediment where streams flow out of the mountainous areas has formed large alluvial fans. The streams frequently change course as additional sediment is deposited on the fans. As streamflow approaches the outer edge of the alluvial fans, where channels are poorly defined, the water spreads out into an overland type flow. Floodwaters from Three-Mile Draw, Sulfur Draw, and several unnamed draws merge in or above the Wild Horse farming area and follow an undefined course until they reach Wild Horse Draw.

There is no known data available concerning quality of watershed runoff and streamflow. However, "Texas Water Quality Standards," October 1973, published by the Texas Water Quality Board, lists criteria that can be utilized to determine water quality in a general sense. The general criteria set forth are applicable to all surface water in Texas at all

times and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena. The criteria, which is extracted from the above mentioned publication, are as follows:

"1. Taste and odor producing substances shall be limited to concentrations in the waters of the State that will not interfere with the production of potable water by reasonable water treatment methods, or impart unpalatable flavor to food fish, including shellfish, or result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the waters.

"2. Essentially free of floating debris and settleable suspended solids conducive to the production of putrescible sludge deposits or sediment layers which would adversely affect benthic biota or other lawful uses.

"3. Essentially free of settleable suspended solids conducive to changes in the flow characteristics of stream channels, to the untimely filling of reservoirs and lakes, and which might result in unnecessary dredging costs.

"4. The surface waters in the State shall be maintained in an aesthetically attractive condition.

"5. There shall be no substantial change in turbidity from ambient conditions due to waste discharges.

"6. There shall be no foaming or frothing of a persistent nature.

"7. There shall be no discharge of radioactive materials in excess of that amount regulated by the Texas Radiation Control Act, Article 4590(f), Revised Civil Statutes, State of Texas and Texas Regulation for Control of Radiation. Radioactivity levels in the surface waters of Texas, including the radioactivity levels in both suspended and dissolved solids for the years 1958 through 1960, were measured and evaluated by the Environmental Sanitation Services Section of the Texas State Department of Health in a report prepared for and at the direction of the Health Department by the Sanitary Engineering Research Laboratory at the University of Texas. The document is entitled, 'Report on Radioactivity--Levels in Surface Waters--1958-1960' pursuant to contract No. 4413-407 and is dated June 30, 1960. This document comprises an authoritative report on background radioactivity levels in the surface waters in the State and quite importantly sets out the locations where natural radioactive deposits have influenced surface water radioactivity. The impact of radioactive discharges that may be made into the surface waters of Texas will

be evaluated and judgments made on the basis of the information in the report which was at the time made, and may still be the only comprehensive report of its kind in the nation.

Radioactivity in fresh waters associated with the dissolved minerals (measurements made on filtered samples) shall not exceed those enumerated in U.S. Public Health Service, Drinking Water Standards, Revised 1962, or latest revision, unless such conditions are of natural origin.

"8. The surface waters of the State shall be maintained so that they will not be toxic to man, fish and wildlife, and other terrestrial and aquatic life.

With specific reference to public drinking water supplies, toxic materials not removable by ordinary water treatment techniques shall not exceed those enumerated in U.S. Public Health Service, Drinking Water Standards, 1962 edition, or later revision.

For a general guide, with respect to fish toxicity, receiving waters outside mixing zones should not have a concentration of nonpersistent toxic materials exceeding 1/10 of the 96-hour TLm., where the bioassay is made using fish indigenous to the receiving waters. Similarly, for persistent toxicants, the concentrations should not exceed 1/20 of the 96-hour TLm.

In general, for evaluations of toxicity, bioassay techniques will be selected as suited to the purpose at hand. However, bioassays will be conducted under water quality conditions (temperature, hardness, pH, salinity, dissolved oxygen, etc.) which approximate those of the receiving stream as closely as practical.

"9. As detailed studies are completed, limiting nutrients identified, and the feasibility of controlling excessive standing crops of phytoplankton or other aquatic growths by nutrient limitations is determined, it is anticipated that nutrient standards will be established on the surface waters of the State. Such decisions will be made on a case-by-case basis by the Board after proper hearing and public participation. The establishment of a schedule for decisions as to the need for nutrient standards for specific waters and what standards should be adopted is not feasible at this time.

"10. The surface waters of the State shall be maintained so that no oil, grease, or related residue will produce a visible film of oil or globules of grease on the surface, or coat the banks and bottoms of the watercourse."

Visual inspection of the watershed reveals there are presently no sources of pollution from activities of man that would cause failure of watershed runoff to meet those criteria.

Diversions or levees have been constructed in an attempt to control floodwater originating in the watershed. In 1929, the Texas and Pacific Railroad Company installed a floodwater diversion above Van Horn in an attempt to provide flood protection for railroad facilities and the city of Van Horn. The county and land users have installed diversions to divert floodwater away from the county air field and irrigated cropland in the Wild Horse farming area. These diversions or levees are adequate for small, frequently occurring floods, but do not effectively control large floods.

The Trans-Pecos Region of Texas has a very complicated geologic history of uplifting and subsidence, faulting and folding, volcanic activity, and igneous intrusion. These have all had a profound effect on the geology of the watershed as it is today. The mountains in the watershed are fault-block mountains. The Beach Mountains and portions of the Carrizo and Baylor Mountains are composed primarily of Precambrian and Cambrian metamorphosed sandstone and conglomerate; and Ordovician limestone, dolomite, and sandstone. Also present, but less extensive in area, are Permian limestone, dolomite, shale, marl, and conglomerate; rock of volcanic origin which is probably Tertiary in age; Quaternary terrace deposits of gravel; and Recent colluvial, alluvial, and aeolian deposits.

The Precambrian Allamore Formation is the oldest geologic unit in the watershed. It consists of thin to thick bedded cherty limestone, phyllite, and volcanic rock. Shallow intrusions of igneous origin can be found in some areas of the formation. The exact thickness of the formation has not been determined, but it is believed to be several thousand feet thick.

The Hazel Formation, also Precambrian in age, overlies the Allamore Formation. The base of the Hazel Formation is a conglomerate composed of poorly sorted fragments of Allamore limestone, indicating a disconformity between the two formations. This basal conglomerate is overlain by massive, indistinctly bedded, fine-grained, well indurated, brick-red sandstone. The entire formation is approximately 5,000 feet thick.

The Hazel Formation and the Allamore Formation are slightly metamorphosed which is partially due to the complex history of thrust faulting and folding that took place after Hazel sediment was deposited and before the overlying Precambrian-early Cambrian Van Horn Sandstone was laid down.

The Van Horn Sandstone Formation lies unconformably on the Hazel Formation. This formation is comprised of continental, post-orogenic sediment that

is medium to coarse-grained, cross-bedded, thick-bedded, and yellow-brown to maroon sandstone and arkose in the upper part. The lower part is characterized by a conglomerate of well rounded pebble to boulder-size fragments in an arkosic sand matrix. The Van Horn Sandstone is faulted and tilted, but not folded and metamorphosed as the underlying Hazel and Allamore Formations.

Ordovician strata unconformably overlie the Van Horn Sandstone and older rocks in the Beach Mountains. These strata, in ascending order, are the Bliss Sandstone Formation, El Paso Formation (basal calcareous sandstone with overlying limestone) and the Montoya Dolomite Formation. Rocks of the Silurian, Devonian, Mississippian, and the Pennsylvanian systems are not found in the watershed. The Hueco Limestone Formation, which belongs to the Permian System, is present in the watershed as cliff-forming cap rock on the mountains. This formation consists of a basal marl, red shale, conglomerate member overlain by a thin to thick-bedded limestone.

The eastern one-half of the watershed lies within a large, north-south trending graben (the intermontane enclosed basin previously referred to). Quaternary bolson deposits of lenticular gravel, sand, silt, and clay have accumulated in this area to a thickness of more than 800 feet. The edge of the area at the foot of the Beach Mountains is a moderatly sloping outwash area of interfingering and overlapping alluvial fans.

Terrace gravel of the Quaternary Leona Formation, and Recent colluvial, alluvial, and aeolian deposits are also present in the watershed.

In addition to the previously mentioned Precambrian faulting, normal faulting of Tertiary or later age has occurred in all exposed strata. 1/

The only account of an earthquake in the area during recorded history was on August 16, 1931. Moderate after shocks were recorded on August 18 and November 3 of the same year. The epicenter of the tremor was near Valentine, Texas, approximately 40 miles south of the watershed. The intensity of the tremor at Van Horn, Texas, according to the "Modified Mercalli Intensity Scale of 1931" was VI-VII. 2/ From an earthquake of this magnitude, persons in automobiles can detect movement. Damage to well designed and constructed buildings is negligible, however, poorly built structures can be expected to sustain some damage. Presently, it is impossible to predict the magnitude and time earthquakes will occur in the region. If there is another tremor, it could occur tomorrow, or thousands, or possibly millions of years in the future.

1/ In addition to field investigations by SCS geologists, the Geologic Atlas of Texas, Van Horn - El Paso Sheet, Bureau of Economic Geology, The University of Texas at Austin, was used to describe the geology of the watershed.

2/ United States Earthquakes Bulletin, 1931 Coast and Geodetic Survey, United States Department of Commerce.

Soils in the watershed are included in the Southern Desertic Basins, Plains, and Mountains Land Resource Area. Due to the low annual precipitation, all areas used as cropland must be irrigated to produce cotton, grain sorghum, onions or any other crop grown in the watershed. Pastureland and hayland also require irrigation. Rangeland is not irrigated. In the mountainous western and extreme northern portions of the watershed, soils are on very steep or undulating slopes. Much of the very steeply sloping area is bare rock. The Lozier series is representative of the soils occurring on the steeply sloping areas. This series is shallow, moderately permeable, stony, and very gravelly loam. Lozier soils are not suited for cropland and are used exclusively as rangeland. Typical soils on the undulating slopes are shallow, moderately permeable, stony, and very gravelly loams of the Delnorte and Upton series. Delnorte and Upton soils are not suitable for growing crops and are used as rangeland.

Soils on the alluvial fans are moderately to rapidly permeable, calcareous, gravelly loam and fine sandy loam of the Augustin and Canutio series. Augustin soils with slopes as much as three percent are suitable for cropland. However, none of these soils in the watershed with slopes greater than one percent are presently being used as cropland. Canutio soils are not suitable for cropland and are used as rangeland.

Toward the eastern periphery of the watershed (Wild Horse farming area) soils are moderately permeable Reakor loam and clay loam, moderate to rapidly permeable Pajarito fine sandy loam, and slowly permeable Verhalen clay. These are all deep soils with the potential of producing abundant crops with proper application of the ground water presently being used for irrigation.

Land use within the watershed is shown in the following tabulation:

Land Use	Acres	Percent
Cropland (Irrigated)	8,300	8.7
Pasture and Hayland	100	0.1
Rangeland 1/	84,580	88.7
Miscellaneous 2/	2,380	2.5
	95,360	100.0

The original vegetative community was primarily a desert shrub grassland. Woody plants consisted of a thin stand of desert shrubs such as creosotebush 3/ (Larrera divaricata), tarbush (Flourensia cernua),

1/ Includes 8,800 acres used primarily as wildlife-recreation land.
2/ Includes roads, highways, railroad rights-of-way, urban area, farmsteads, ranch headquarters, airport, etc.
3/ United States Department of Agriculture, Soil Conservation Service, 1971, National list of scientific plant names.

Topography, vegetation, and soils in drainage area of Sulfur Draw in northwestern portion of watershed.

Topography, vegetation, and soils in drainage area of Three-Mile Draw in western portion of watershed.

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View to the north from existing diversion above Van Horn.

View to the northwest from the vicinity of Van Horn.

TOPOGRAPHY, VEGETATION, AND SOILS IN THREE-MILE AND SULFUR DRAW WATERSHED.

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allthorn (Koeberlinia spinosa), ocotillo (Fouquieria splendens), and lecheguilla (Agave lecheguilla), desertwillow (Chilopsis linearis), mesquite (Prosopis juliflora), and other woody species occurred along the stream courses. Grasses on the more arid sites consisted of a rather open stand of desert grasses such as black grama (Bouteloua eriopoda), rough tridens (Tridens elongatus), bush muhly (Muhlenbergia porteri), mesa dropseed (Sporobolus flexuosus), hairy grama (Bouteloua hirsuta), chino grama (Bouteloua breviseta), and threeawns (Aristida spp.). On more favorable sites a thin stand of sideoats grama (Bouteloua curtipendula), cane bluestem (Andropogon barbinodos), and green sprangletop (Leptochloa dubia) occurred. Tobosa (Hilaria mutica) and vine-mesquite (Panicum obtusum) occurred on the fine textured soils near Wild Horse Draw. Perennial forbs and woody species comprised less than 10 percent of the total composition.

The present rangeland vegetation within the watershed is significantly different from the original or climax vegetation. Grazing by domestic livestock, which began about 1895, has altered the composition by reducing the more palatable forb and grass species. Early stock raisers in the area had little concept of the grazing capacity of rangeland and overuse of forage species was widespread until relatively recent times. As climax grasses and forbs were eliminated by overuse, they were replaced by plants capable of surviving overuse or by plants which were not readily grazed by livestock. Plants which increased or invaded with overuse include threeawns, sand dropseed (Sporobolus cryptandrus), fluffgrass (Erioneuron pulchellum), hairy tridens (Tridens pilosus), creosotebush, mesquite, lecheguilla, and annual species of grasses and forbs.

As a result of past overuse, large areas of rangeland have not regained their former level of productivity and remain generally in poor to fair condition. Improved range management and reduced stocking rates are accepted as necessary elements of a successful ranching operation by the majority of present land users. Rangeland response to overgrazing and proper range management are illustrated by charts 1 and 2 on the following page. Chart 3 indicates the grazing capacity of various range sites in various condition classes.

Hydrologic cover conditions correspond directly with the quantity of vegetative cover and range from poor to good within the watershed.

Water supplies for irrigation, the city of Van Horn, rural domestic uses, and livestock are obtained from wells. Aquifers in the watershed area are lenticular sand and gravel. Water levels in these strata average about 400 feet below the ground surface. The top of the water table dips to the north at approximately 23 feet per mile. However, the slope of the land to the north is generally greater than the water table and water not withdrawn from wells eventually comes to the surface in central Culberson County where it evaporates.

RANGE CONDITION

CHART 1

PERCENTAGES OF CLIMAX VEGETATION IN RESPONSE TO YEARS OF OVERGRAZING

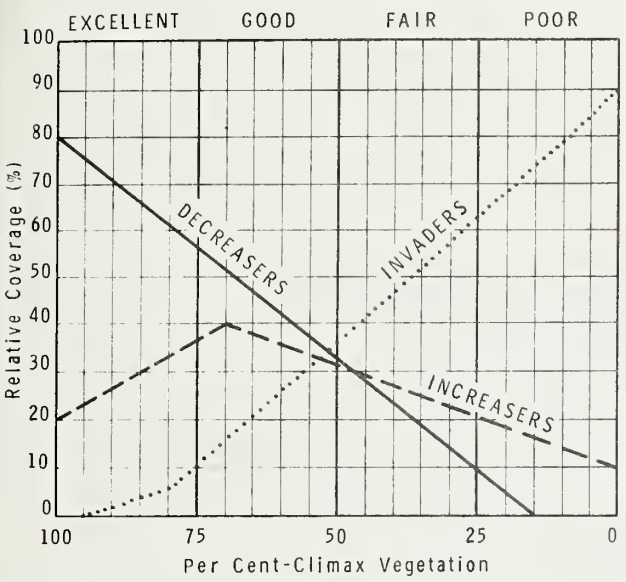
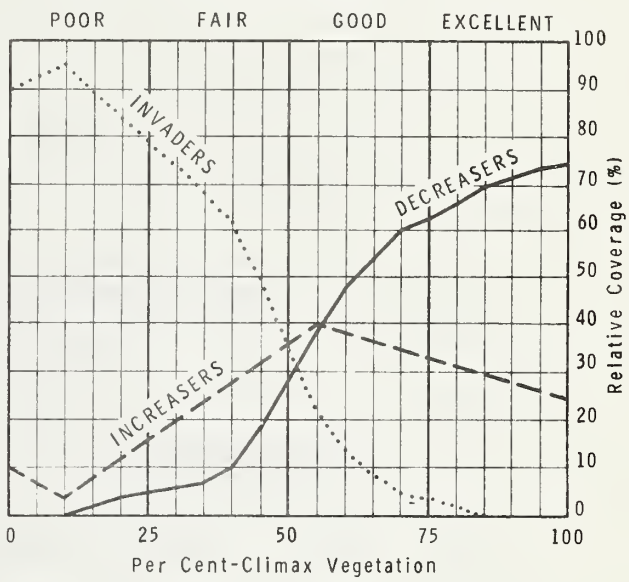


CHART 2

RESPONSE OF CLIMAX VEGETATION TO YEARS OF GOOD RANGE MANAGEMENT



DECREASERS - Plants present in the potential plant community which decrease with overgrazing.

INCREASERS - Plants present in the potential plant community which initially increase with overgrazing but eventually decrease if overgrazing is prolonged.

INVADERS - Plants not present in the potential plant community but which encroach and occupy the area vacated by the decreasers and increasers under prolonged over-use.

CHART NO. 1

This chart illustrates the reaction of rangeland vegetation to prolonged periods of overgrazing. The more desirable plants decrease. Others present increase for a short time and then decrease as the grazing load shifts to them. Undesirable plants present only in trace amounts invade and occupy the area vacated by the original plants.

CHART NO. 2

POOR CONDITION

The invader plants increase in percent ground cover during the first few years when grazing pressure is lightened or wholly removed. This increase continues as long as there is bare ground for this type of plant to occupy. The increaser plants are low in vigor and are slow to start spreading. Both increaser plants and the trace of decreaser plants begin to occupy more area as the cover and litter accumulates and plant vigor increases. At this stage, the less competitive invaders, such as annuals, begin to diminish and give way to plants of higher order.

FAIR CONDITION

The increaser plants continue to spread and compete more heavily for the water, nutrients, and light. Decreaser plants gain vigor, produce seed, and begin to spread more rapidly by establishing new plants by vegetative means. The invader species start to decline rapidly as competition becomes more and more severe.

GOOD CONDITION

Decreaser plants increase more rapidly. Invader species continue to be eliminated as competition with plants of higher ecological status becomes more severe. Increasers spread for a short time until competition with plants of higher rank force them to diminish gradually.

EXCELLENT CONDITION

Invader plants are soon reduced to only a trace of the composition. Adjustment between the climax plants continues to take place as the decreasers slow down their spread but continue a gradual climb in percent coverage. The increaser species are gradually reduced to their proper percentage in the highly competitive community. Decreasers may not attain as high a percentage of the composition as they occupied before deterioration, due to some species having been eliminated completely.

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Chart 3

Grazing Capacity [1/] of Rangeland by Range Site and Condition Class

Range Site	Condition Class			
	Excellent	Good	Fair	Poor
Clay Flat Site	26-43	32-53	46-91	64-107
Deep Upland Site	28-43	32-53	53-107	80-213
Draw Site	18-26	21-32	26-43	40-80
Gravelly Site	43-53	49-80	64-128	107-320
Limestone Hill and Mountain Site	32-46	40-58	53-91	80-213
Sandy Loam Site	28-40	40-53	49-80	80-213

1/ Expressed in acres required to furnish forage for one animal unit on a year-long basis.

Ground water recharge is limited to small ephemeral streams emerging from the mountainous area and flowing into porous alluvial material. This recharge must occur during times of heaviest rainfall (July, August, and September). However, ground water quantity is considered to be adequate to meet the anticipated future needs of Van Horn and for irrigation of crops. The static water level in 1951 was at a depth of about 400 feet. Due to a heavy demand and pumping, the water level declined from five to fifteen feet during the period of 1955 to 1965. The maximum decline occurred toward the center of the basin. The water level is now relatively stable.

The water is not excessively mineralized, however, free sodium content is considered to be high, ranging from approximately 45 to 75 percent. With proper management, most of the soils in the Wild Horse farming area are suitable for irrigation use of high sodium content water because of their moderate to rapid permeabilities and slight gypsum content. The pH is slightly alkaline, averaging 7.5. 1/

According to the Bureau of Mines, mineral resources known to be in the vicinity of the watershed (Culberson and Hudspeth Counties) are petroleum, natural gas, gypsum, sulfur, nitrate, asbestos, talc, beryllium, copper, silver, stone, sand, and gravel. However, commercial quantities and development of mineral resources in the watershed are limited. The Hazel Mine, opened in 1856, was operated intermittently until 1947. Available records on total production are not complete and only estimates can be made. Estimates indicate that at least 110,000 tons of ore were produced which yielded in excess of 1,500,000 pounds of copper and 4,000,000 ounces of silver. 2/ Presently the machinery and improvements at the mine are in a state of disrepair and a major portion of the mine shaft is flooded. Additional operations are not anticipated unless much more efficient methods of recovering the ore are devised or the recent increases in copper and silver prices should continue in a sustained upward trend. Sand, gravel, and talc are presently being quarried and mined in the watershed. The production of these materials is limited in quantity and has a minimal influence on the watershed economy.

Economic Data

The agricultural economy of the watershed is dependent on the production and sale of cash crops and livestock. About 70 percent of the total agricultural income in the watershed is derived from the sale of cash crops and 30 percent from the sale of livestock.

1/ Longnecker, D.E. and Lyerly, P.J., 1959. Some Relations Among Irrigation Water Quality, Soil Characteristics and Management Practices in the Trans-Pecos Area. Texas Agricultural Experiment Station MP-373.

2/ King, P.B. and Flawn, P.T. 1953, Geology and Mineral Deposits of Pre-Cambrian Rocks of the Van Horn Area, Texas; p. 154.

Major crops grown in the flood prone area and average yields per acre are: cotton, 800 pounds; grain sorghums, 5,000 pounds; oats, 40 bushels, and 6 animal unit months of grazing; and onions, 600 fifty-pound sacks. Sudan hay yields about five tons per acre. The average carrying capacity of rangeland is about six animal units per section.

The availability of irrigation water, capability of land, and market prices being paid for crops are major factors determining use of agricultural land in the watershed. Agricultural land not devoted to crop production is used primarily for the grazing of cattle and for wildlife.

There are approximately 25 farms and ranch units wholly or partially within the watershed. Ranch units average about 6,900 acres in size while farms average about 740 acres. There has been a gradual increase in size and a decrease in the number of farms. About 42 percent of the ranches and 30 percent of the farms are owner-operated.

The estimated current market price of rangeland varies from $35 to $45 per acre while cropland varies from $350 to $400 per acre. The variation in land prices is dependent on several factors including location, accessibility, soil capability, and the availability of irrigation water.

All the farms and ranches in the watershed gross more than $2,500 annually from agricultural sales. Approximately 30 percent of the farm and ranch operators work off the farm 100 days or more in 1970.

It is estimated that about 10 percent of the agricultural land in the area is in operating units using one and one-half man-years or more of hired labor.

The "Labor Force Estimates for Texas Counties - April 1974," shows a labor force of 2,470 for the two counties within which the watershed is located. Approximately 2.0 percent, or 50 workers are unemployed. This is below the state and national rates of unemployment. Approximately 31.6 percent, 780 workers, are employed in the agricultural sector. The nonagricultural sector employs 1,640 workers; 60 workers in the manufacturing sector, and 1,560 in the nonmanufacturing sector.

The combined population for Culberson and Hudspeth Counties are projected to decline from a total of 5,821 in the year 1970 to 4,800 in 1990. 1/ This decrease in population was predicated upon a declining birth rate during the 1970-90 period.

The city of Van Horn, located on the southern boundary of the watershed, has a population of 2,240 (1970 census). It is the county seat of

1/ Preliminary Population Projections, Series B, for Texas Counties: 1975-1990, Population Research Center, The University of Texas at Austin, Austin, Texas.

Culberson County and the commercial center for the surrounding farm and ranch area, providing marketing and supply services which are important in the local community. Situated at the junction of Interstate Highway 10 (U.S. Highway 80), U.S. Highway 90, and State Highway 54, in a sparsely populated region, Van Horn provides facilities for many tourists and travelers.

The watershed is served adequately by highways previously listed and Farm Roads 2185 and 2809. There are also several county roads which provide access to the watershed. The Texas and Pacific Railroad has loading facilities in Van Horn.

Fish and Wildlife Resource Data

The fish and wildlife habitat, species, and populations in the watershed are described in the following paragraphs extracted from the Fish and Wildlife Service report dated December 22, 1970.

> "There is no fish habitat in the project area and none is expected to develop in the future without the project.
>
> The entire watershed is located within the Trans-Pecos Game Region of the state. Principal wildlife species include mule deer, scaled quail, mourning dove, jackrabbit, cottontail, gray fox, and coyote. Wildlife of lesser importance because of their relatively low populations are white-winged dove, kit fox, bobcat, mountain lion, raccoon, skunk, ring-tailed cat, and badger. Bighorn sheep once ranged the higher elevations of this area, but the increased human inhabitation in recent years has pushed the species to more remote areas of the region and none have been reported in the area since the mid 1950's. Waterfowl are not known to frequent the watershed."

Mule deer numbers are highest in the upper part of the watershed in the mountains and foothill areas, and populations are estimated to be about one deer to 64 acres. The mule deer population is very low or absent in the lower portion of the watershed and in the Wild Horse farming area. Scaled quail populations are estimated to be about one bird per ten acres in the watershed. The greatest concentration of scaled quail is along the draws. About 500 white-winged doves and 1,500 to 2,000 mourning doves nest in the watershed. The coyote population is estimated to be one per section. Furbearer populations are low. 1/

The Texas Parks and Wildlife Department has recently released six bighorn sheep in the Sierra Diablo Mountains and plan to release an additional five or six animals in the area in 1974. These animals are not

1/ Personal communication with John Shane, Biologist, Texas Parks and Wildlife Department, Van Horn, Texas.

cited by the U.S. Fish and Wildlife Service 1/ as endangered fauna, but do receive protection in Texas under the Texas Parks and Wildlife Code (Chapter 68, Acts of the 64th Legislature, Regular Session, 1975), which related to nongame and endangered species. A list which includes the bighorn sheep has been filed with the Texas Secretary of State. The list cites those animals threatened with extinction in Texas. This species may occasionally range into the upper portion of the watershed.

The only endangered species as recognized by the U.S. Fish and Wildlife Service that may occasionally visit the watershed is the American peregrine falcon. This bird also receives protection under the Texas Parks and Wildlife Code. Other animals of questionable status and whose natural range includes the watershed are the mountain lion, kit fox, and golden eagle.

Recreational Resources

Approximately 8,800 acres of rangeland in the watershed are used primarily as wildlife-recreation land. This area is used principally for the production and hunting of mule deer and scaled quail. Also, 72,000 acres of rangeland has a secondary use as wildlife-recreation land. About 35,000 acres of this area is leased for private hunting, and the remaining 37,000 acres are used for noncommercial recreation by the owners and operators and their guests. The annual gross income from leasing varies from about 10 cents to 15 cents per acre.

According to the following excerpt from the Fish and Wildlife Service reports:

> "Mule deer are the most sought-after game species of the project area. Ranchers are reluctant to allow any public access, but some properties are leased for deer hunting. Scaled quail and mourning dove are second in popularity. They are the primary game species hunted by landowners and their close friends. Jackrabbits and cottontails are taken in relatively low numbers and are hunted only incidental to quail and doves. Gray foxes, coyotes, and bobcats are moderate in number, but do not receive any significant amount of hunting. Other wildlife species in the watershed have very low population levels and are not hunted. There is no known trapping of fur animals within the watershed."

Archeological and Historical Values

There are no historic or archeological sites within the watershed that are listed in or in the process of nomination to the National Register

1/ U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1974. United States List of Endangered Fauna. 22pp.

of Historic Places. However, significant archeological resources of scientific interest have been located in the watershed.

Dr. S. Alan Skinner and Mr. C. Britt Bousman, archeologists with the Archaeology Research Program, Department of Anthropology, Southern Methodist University, conducted a reconnaissance survey on portions of the watershed to locate historical and archeological resources that could be effected by project structural measures. The reconnaissance survey located 11 archeology sites and nothing of historical significance. The 11 prehistoric sites, which appear to have been occupied during the period 1000 B.C. to A.D. 1500, consist of eight open sites and three rock shelters. Open campsites occur on alluvium which will be crossed by the planned floodwater diversion and on ridges adjacent to the area required for Floodwater Retarding Structure No. 1. All the shelters are in the vicinity of planned Floodwater Retarding Structure No. 2. All sites are small in area and have a limited artifact assemblage. Maintenance activities attributed to the artifacts include food processing, chipped stone tool manufacture, hunting, cooking, hide preparation, and stone quarrying. Food processing and tool manufacturing appear to dominate the assemblages.

When all potential structural measures were located in detail the Archaeology Research Program, Southern Methodist University, performed additional studies and evaluations of the potentially affected sites. All 11 of the sites were reevaluated by Southern Methodist University to determine if they would be affected and to ascertain the eligibility of any site, or sites for nomination to the National Register of Historic Places. As a result of this reevaluation which included comprehensive testing of three sites, none of the sites were considered worthy of nomination. On the basis of the reevaluation and testing, it was concluded that the installation of the planned project on the watershed will not affect any archeological sites eligible for nomination to the National Register of Historic Places. The State Historic Preservation officer reviewed the entire case file relative to all cultural resources to be affected by the project and concurred that none of the 11 archeological sites located are eligible for nomination to the National Register of Historic Places.

Soil, Water, and Plant Management Status

The watershed is composed primarily of rangeland which is grazed by livestock and wildlife. Rangeland exceeds 88 percent of the total land area within the watershed. Little change in land use is expected to occur in the future. Land used primarily for wildlife production is expected to increase as demand for hunting becomes greater.

There are 25 farm and ranch units located wholly or partially within the watershed. Twenty-three District cooperators have developed resource conservation plans in cooperation with the High Point Soil and Water Conservation District. These plans cover 90,597 acres, or 95 percent of the watershed.

The High Point Soil and Water Conservation District is a local subdivision of state government with elected directors. The district is dedicated to the conservation of land, water, wildlife, and related resources for the benefit of all.

Conservation plans developed by land users in consultation with resource personnel assisting the soil and water conservation district are the basis for most land treatment measures. Conservation plans are documents which contain material relative to the use and treatment of soil, water, plant, wildlife, and related resources of an entire individual land unit. Conservation plans contain soil, water, plant, and other needed inventories; data on critical conservation problems; and a record of decisions which the land user has made to reach his conservation objectives. The length of time required to fully implement a plan is contingent upon many factors, including: available labor, capital, materials, and time.

Conservation land treatment has been a primary objective of the High Point Soil and Water Conservation District since its organization in 1948. The District actively assists land users in the watershed and surrounding area in applying and maintaining needed conservation measures on a majority of farms and ranches.

About 82,000 acres within the watershed are considered to be adequately protected from erosion. Rangeland is considered to be adequately protected when proper grazing use is applied and maintained. Rangeland which has 2,000 pounds or more of living or dead cover maintained on the land through critical erosion periods except during droughts, is also considered to be adequately protected. Critical area treatment must be applied to areas where needed before rangeland is considered adequately protected. Irrigated cropland which has slopes of less than one percent is considered to be adequately protected. Land treatment measures have been applied to date at an estimated expenditure of $78,860 by landowners and operators (table 1A).

A soil survey is the classification, mapping, correlation, and interpretation of various types of soils in an area. Soils are classified considering their physical, chemical, and mineralogical characteristics. The classified soils are located and outlined on a map or aerial photograph of the area being surveyed, and correlated to determine the relationship of the various soils in the area to one another and to similar or identical soils identified in other areas. Soil survey interpretations indicate the limitations and suitability of a soil for selected uses.

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. The only criteria used to separate one range site from another are differences in the kinds, proportions, or total annual yield of the climax plant community. Similar soils often have the ability to support similar

plant communities and may be grouped in a single range site. Range sites are delineated on maps or aerial photographs to assist the land user in identifying problems and treatment needs for his conservation plan.

Soil surveys and range site mapping have been accomplished on 11,210 acres and 78,720 acres, respectively. The surveys and range site mapping accomplished to date are considered to be adequate for present and anticipated future land uses.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Management

Application of land treatment measures is difficult due to limited and unpredictable rainfall patterns within the watershed. This factor is very significant for conservation measures applied on rangelands and areas unsuited for irrigation. Differences in amount and distribution of rainfall are reflected in forage production. During years of below average rainfall forage production may be only one-third as much as during years of high rainfall. Care must be exercised by rangeland operators to insure that desirable vegetation destruction due to overgrazing by livestock does not occur during droughts. Rangeland subjected to overuse during drought periods may require several years of light grazing or total rest to recover their former levels of productivity. Prolonged overgrazing often results in soil loss and an invasion of noxious plants which seriously reduces future production of the resource. Grazing capacity of rangeland in the watershed is limited. A stocking rate of one animal unit to 100 acres or more is often required to obtain proper use of forage species. This limited return per acre restricts the amount of capital which can be reasonably expended on rangeland.

Adequate livestock water is not available in many areas of the watershed. This limits the degree to which planned grazing systems can be implemented. About 1,500 animal units of cattle are estimated to be utilizing rangeland at the present time.

Livestock grazing in the watershed is limited to cattle. There is little competition between cattle and deer for forage. Plants utilized by deer show little evidence of overuse. 1/ Deer numbers appear to be declining in the watershed. Reproduction is satisfactory, but fawn survival is low. Declining mule deer numbers have caused some land users to reduce the annual harvest of mule deer by hunters.

1/ Personal communication with John Shane, Biologist, Texas Parks and Wildlife Department, Van Horn, Texas, April 1974

Floodwater Damage

Flooding on 13,200 acres of land within the watershed is caused by runoff originating in the mountainous and upland drainage areas of Three-Mile and Sulfur Draw and small unnamed draws. It is estimated that a flood having a predicted recurrence interval of once every 100 years will inundate about 9,040 acres, including 200 acres in the city of Van Horn. However, not all of this area will be inundated by a single flood event. During the interval between floods, minor changes in the area subject to damage, such as installation of small dikes, road fills, irrigation ditches, or land leveling, may alter the course of flood flows. The courses of floodwaters cannot be predicted in the Wild Horse farming area and on rangeland to the west due to overland flow conditions. Most of the damages to urban areas of Van Horn are caused from runoff originating in the Three-Mile drainage area.

About 1,300 acres of flood prone area in the eastern portion of the watershed are common flood plain with Wild Horse Draw. Damages on this common flood plain from floodwater originating in Wild Horse Draw occur on the average of once every 15 years.

The adverse physical and economic effects of flooding have been felt throughout the watershed and have prompted local participation in efforts to alleviate the flood problem. Diversions or levees have been installed in attempts to divert floodwaters from Three-Mile Draw and Sulfur Draw away from the urban area of Van Horn, county air field, and irrigated cropland in the Wild Horse farming area (figure 1).

A diversion protects railroad facilities, the city of Van Horn, and the city cemetery from floods expected to occur on the average of once every 25 years or less. The diversion outlet is east of State Highway 54 about two miles north of Van Horn (figure 1). The outlet is a wide and shallow channel formed by runoff in Three Mile Draw and diverted flow from the diversion. The diversion is semi-compacted earth fill and has received a minimum of maintenance since its construction in 1929. Even though the diversion is adequate for protection from frequently occurring flood flows, it is subject to failure under flood conditions caused by less frequent, more severe, and intense storms.

The floodwater diversion protecting the county air field provides protection from floods expected to occur on the average of once every 10 years or less. It diverts easterly flowing water to the north and discharges into a drainage and bar ditch for Farm Road 2185 (figure 1).

The diversion installed above a portion of the Wild Horse farming area was constructed with private funds to provide protection from floods expected to occur every 10 years or less. Diverted water flows from each end of the diversion to a centrally located outlet and discharges into a waterway designed to contain and convey the 10-year storm runoff to Wild Horse Draw (figure 1).

Floodwater damage from flood of August 1966 to irrigation systems in the Wild Horse farming area.

Floodwater Damage from flood of August 1966 in the Wild Horse farming area. Floodwater completely innundated irrigated cotton crop.

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Bridge Damage
Bridge on Highway 54 spanning Sulfur Draw
The south abutment was washed out in August 1966.

Highway 54 road damage
Note sediment deposition.

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Floodwater damage to urban property in Van Horn from the flood of September 4, 1913. This flooding was prior to the railroad constructing a diversion around the city of Van Horn.

(Photographs courtesy of Miss Rosa Lee Wylie)

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Damaging floods in the agricultural area can be expected on an average of once every two to three years. Most floods occur during the months of June, July, and August when most crops are highly susceptible to damage. The acreage and location of area inundated is dependent upon the areal extent, intensity, and amount of precipitation falling on the upland and mountainous areas. Cumulative totals of recurrent flooding show an average of 1,515 acres flooded annually during the evaluation period. In addition to causing physical damages (scouring and deposition of sediment) with subsequent reduction of crop yields on agricultural land, other agricultural property such as concrete lined ditches, pipelines, and other appurtenances for water control are severally damaged by floodwater.

The most disastrous flood in recent years occurred on August 21-22, 1966. Recorded rainfall amounts for this storm varied from 10 inches in the upper portion of the watershed to an offcial 7.23 inches at Van Horn. 1/ The recurrence interval of the resulting flood peak was estimated to be about 25 years. The existing diversion protecting the city of Van Horn and surrounding area was overtopped in several places, but only minor flooding occurred in Van Horn from local runoff. Damage to agricultural and nonagricultural properties was high. Crops were destroyed, irrigation systems were devastated, and cropland was eroded or covered with infertile sediment. State Highway 54, north of Van Horn, was closed for three days because the abutment on the Sulfur Draw bridge was swept away by the rushing waters. Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be $306,980.

Other large floods that caused significant floodwater damages to the agricultural area occurred in 1963 and 1964. Large floods that caused damages to properties in Van Horn occurred in 1913, 1927, and 1964. The 1913 and 1927 floods occurred before the existing diversion was constructed.

Under present level of development, it is estimated that approximately 110 homes would suffer direct floodwater damage from a flood having a predicted interval of once every 100 years. The estimated direct floodwater damages to existing urban properties that would result from such a flood are estimated at $75,470 at the present level of development.

For the floods evaluated, which include floods up to and including the 100-year frequency, the total direct floodwater damage is estimated to average $80,900 annually (table 5). Of this amount, $52,260 are crop and pasture damage, $22,000 are other agricultural damage, $2,860 are road and bridge damage outside the urban area, and $3,780 are to urban properties. Of the damage to urban properties, $3,550 are to residential properties, and $230 are to city streets and the city cemetery.

1/ "Climatological Data, Texas, August 1966," U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service.

Erosion Damage

The estimated average annual upland erosion rate is 0.97 tons per acre. This low rate is primarily because of the infrequency of high intensity rainfall and predominance of stony or gravelly soils on the steeper slopes which are all used as rangeland. Sheet erosion accounts for 87 percent, gully erosion six percent, and streambank erosion seven percent of the upland erosion.

Sheet scour is the significant type of erosion on approximately 840 acres of irrigated cropland and ranges from approximately six to 15 inches in depth. It is estimated that this scour has reduced the productive capacity of 33 acres by 10 percent, 775 acres by 20 percent, and 32 acres by 30 percent. The average annual value of this damage is estimated to be $47,520 at current normalized prices (table 5).

Sediment Damage

About 385 acres of irrigated cropland in the Wild Horse farming area has been damaged by sediment. It is estimated that the productive capacity of 129 acres has been reduced 10 percent by deposits of silty, clayey sand. The average thickness of these deposits is about one foot. The productive capacity on an additional 256 acres has been reduced 20 percent. The deposits of sediment on this area are comprised of silty sand and small amounts of gravel, averaging about two feet in thickness. At current normalized prices, the average annual sediment damage on 385 acres of irrigated cropland is $17,650 (table 5). Deposition is occurring on other areas, but due to land use, nature of soils affected, type of sediment, and low rate of accumulation, the damage was not considered significant, and therefore not evaluated in monetary terms.

On an average annual basis, 13 acre-feet of sediment derived from the watershed is yielded to Wild Horse Draw. This amounts to an average annual sediment concentration of 5,600 milligrams per liter in 0.76 centimeter (0.3 inch) of annual runoff.

In addition to damaging valuable cropland and being a pollutant in runoff water, sediment from the watershed has contributed to channel filling and aggradation in Wild Horse Draw resulting in more frequent and severe flooding.

Indirect Damage

Indirect damages such as interruption of travel, losses sustained by businesses, evacuation of premises when floods threaten, and similar losses are estimated to average $14,990 annually.

Irrigation Water

Approximately 8,300 acres in the watershed are irrigated cropland. About 4,400 acres are irrigated annually with ground water. The ground

water contains considerable amounts of chloride, sodium chloride, and bicarbonate. The content of calcium and sulfate is very low, and there is no residual sodium carbonate. 1/

Accumulations of soluble salts applied to the soil in irrigation water can be a hazard to growing crops. Generally it is not the salt content of the irrigation water that is the problem, but the excessive amounts of salts in the soil that gradually accumulate with repeated application of the water. These accumulations result when water evaporates from the soil surface, leaving the salts as a residue.

Presently the only known method of effectively reducing excessive accumulations of soluble salts is a process known as leaching. This is the removal of the salts in solution from upper soil horizons to lower horizons by the action of percolating water. Due to their depth and moderate to rapid permeabilities, most of the irrigated soils in the watershed can be leached of excessive accumulations of soluble salts. A slight gypsum content in the soils also contributes to controlling salt accumulations. Presently, due to the effectiveness of leaching and the gypsum content, there are no problems with soluble salt accumulations and none are expected in the future with the use of proper application and management practices for irrigation water.

Recreation

Opportunities for fishing and other water-based recreation are nonexistent within the watershed or immediate area. The nearest large lake is Red Bluff Reservoir located about 100 miles to the northeast near the Texas-New Mexico border.

Economic and Social

Additional employment opportunities are needed for the 50 unemployed workers in the area. The population of Van Horn increased from 1,953 persons in 1960 to 2,240 persons in 1970, an increase of 14.7 percent. Further increases in population could be anticipated with a concentrated effort in community development and additional employment opportunities.

RELATIONSHIP TO LAND USE, POLICIES, AND CONTROLS

There are no approved or proposed federal, state, or local land use plans, policies, and controls pertaining to the watershed or surrounding area.

1/ Longnecker, D.E., and Lyerly, P.J., 1959, Some Relations Among Irrigation Water Quality, Soil Characteristics and Management Practices in the Trans-Pecos Area, Texas Agricultural Experiment Station MP-373.

PROJECTS OF OTHER AGENCIES

There are no existing or proposed water resource development projects of any other agencies within the watershed.

There are no known existing or proposed downstream water resource development projects of other agencies.

PROJECT FORMULATION

Realizing the social and economic impacts of floodwater damage and the need to move forward with a progressive plan for conservation of soil, water, plant, and related resources, local representatives of the High Point Soil and Water Conservation District, Culberson County Commissioners Court, and the city of Van Horn held meetings to discuss and identify flood problems and reach agreements on soil, water, and plant resource development needs. Informational meetings were held by local organizations prior to initiation of planning and during the planning phase in Van Horn. The initial meeting was held in December 1964, and attended by 23 interested citizens. It was recognized at this meeting that favorable public opinion toward a watershed project was needed before submitting an application for planning assistance to the Texas State Soil and Water Conservation Board. It was also emphasized at this meeting that under the auspices of Public Law 566, a watershed project would be a local endeavor with federal assistance.

Subsequent to approval of the application, a field examination of Three-Mile and Sulfur Draw Watershed was carried out in December 1964 by the Texas State Soil and Water Conservation Board and Soil Conservation Service to make an appraisal of watershed problems, types of improvements necessary for watershed protection and flood prevention, quality of human environment, and effects of possible works of improvement on the environment. Findings of the field examination were publicly discussed at a meeting held for this purpose at Van Horn, Texas.

A field reconnaissance of Three-Mile and Sulfur Draw watershed and a public hearing were held by the Texas State Soil and Water Conservation Board in Van Horn, Texas. The field reconnaissance and hearing provided assurance to Board members that requested assistance was within the scope of Public Law 566; that existing watershed conditions warranted planning assistance; public opinion was in support of a watershed project; and sponsoring local organization had the ability and willingness to fulfill future responsibilities during planning and construction of a watershed project. The Texas State Soil and Water Conservation Board approved the application with a high priority for planning assistance.

The Three-Mile and Sulfur Draw watershed application for assistance under Public Law 566, as amended, was authorized for planning by the Administrator of the Soil Conservation Service on July 22, 1969. The

State Conservationist of the Soil Conservation Service, in his written notification of initiation of work plan development, solicited information and comments from federal, state, and local agencies that might have an interest in the project. Contacts were made with several agencies and individuals during planning to obtain information and assistance during the planning process.

The application for planning assistance for Three-Mile and Sulfur Draw watershed was made prior to implementation of Bureau of the Budget Circular A-95, however, the sponsors provided the El Paso Council of Governments with notification of intent to apply for assistance involving federal funds prior to the start of field planning operations.

Subsequent meetings were held by the sponsoring local organization to inform the general public and involved landowners and to gain opinions and information from interested individuals. Landowners and operators were shown how their properties were involved in potential floodwater retarding structures with the use of maps and on-site observations.

Newspapers serving the watershed area published articles announcing public meetings and reported information and conclusions resulting from the meetings. In addition, individuals whose land was directly involved with potential floodwater retarding structures and the floodwater diversion were notified and invited on an individual basis to attend meetings.

A public information meeting was held on February 20, 1975, in the district courtroom of the Culberson County Courthouse, Van Horn, Texas. The purpose of the meeting was to provide the public current information concerning the status of project planning and impacts resulting from project installation, and provide affected or interested individuals and groups an opportunity to offer their opinions and expertise. Among those present were landowners whose land will be affected, officials of the city of Van Horn and Culberson County, members of the sponsoring local organization, representatives of the local press, interested citizens, and Soil Conservation Service personnel. The location, physical features, and functions of planned structural measures were discussed. Responsibilities of the sponsoring local organization were considered. Alternatives to the planned project and anticipated favorable and adverse impacts with completion of the project were presented. There was no controversy relative to the adverse impacts.

Objectives

An initial study was made by representatives of the Soil Conservation Service and sponsoring local organization to determine watershed problems and possible solutions. After determining the location and extent of the problems and discussing potential solutions, project objectives were formulated. Watershed protection and flood prevention were the primary objectives expressed by the sponsors. The initial intention of the sponsors in regard to flood prevention was to provide protection to

the Wild Horse farming area. The control of floodwater originating in the drainage area of Three-Mile Draw is necessary to obtain the desired level of protection. When it became apparent that a floodwater retarding structure would be required, the sponsors realized that additional flood protection for the city of Van Horn could be attained with a minimum of additional cost to that needed to protect the agricultural area. The sponsors then included among the objectives of the project the intent to provide flood protection for urban areas of Van Horn. The sponsors also wished to consider the feasibility of including additional water storage for recreational purposes in a floodwater retarding structure on Three-Mile Draw.

In addition to expressing the desire for establishment of a complete program for soil and water conservation on the watershed, the following specific objectives were agreed to:

1. attain adequate treatment, by the end of a five-year project installation period, on at least 85 percent of the watershed through the application and establishment of land treatment measures,

2. attain a reduction of 70 to 75 percent in average annual flood damage to agricultural flood plain lands,

3. attain at least a 95 percent reduction in average annual flood damages in Van Horn with consideration given to a flood having a predicted recurrence interval every 100 years, and

4. develop facilities and provide opportunities for public water-based recreation.

Environmental Considerations

The sponsors considered the impacts, both favorable and adverse, in developing the plan for meeting the project objectives. The objectives selected were those that would contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources so that watershed residents can enjoy:

QUALITY IN THE NATURAL RESOURCE BASE FOR SUSTAINED USE

QUALITY IN THE ENVIRONMENT TO PROVIDE ATTRACTIVE, CONVENIENT, AND SATISFYING PLACES TO LIVE, WORK, AND PLAY

QUALITY IN THE STANDARD OF LIVING BASED ON COMMUNITY IMPROVEMENT AND ADEQUATE INCOME

The sponsors selected measures which will help to achieve these objectives and also included measures to minimize adverse impacts whereever practicable.

The additional land treatment measures will contribute to the preservation and enhancement of the environment in the watershed. Land treatment which reduces soil and water losses, assures proper functioning of floodwater retarding and diversion structures, reduces flooding, and improves wildlife resources will be emphasized.

The Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the watershed. Two recommendations were made for preserving or enhancing wildlife resources of the watershed. These recommendations concerned the design of stock watering facilities for use by wildlife and vegetative plantings of value to wildlife. These recommendations are incorporated in the planned land treatment. Two recommendations were submitted regarding the establishment of a fisheries resource. These recommendations were contingent upon adequate water impoundment in a floodwater retarding structure to provide a suitable fish habitat. It was determined that a suitable fish habitat would not exist without the additional recreational water storage which the sponsors, after much deliberation and study, rejected. However, if a suitable fish habitat should be impounded in the future, stocking and management of the resource can be accomplished with assistance from the Texas Parks and Wildlife Department and the Soil Conservation Service.

Archeologists from the Archaeology Salvage Project, Southern Methodist University, located and evaluated eleven archeological sites within or adjacent to the areas required for the floodwater retarding structures and floodwater diversion. As a result of these investigations, it was recommended that further mapping and studies be carried out at nine sites. Subsequently, the additional mapping and studies were accomplished at the nine sites. It was then recommended, and sanctioned by the State Historic Preservation Officer, that salvage or nomination to the National Register of Historic Places is not warranted for any of the archeological sites investigated.

During work plan development, extensive studies were made by the sponsoring local organization and the Service to avoid or at least minimize the displacement or relocation of individuals, farms, and businesses. Under present conditions there are no apparent relocations or displacements that will be caused by installation of the project.

Alternatives

The considered alternatives to the proposed action were: (1) a program of applying land treatment measures for watershed protection; (2) changing the present use of agricultural land to a use less susceptible to damage by flooding, application of land treatment, and purchase of flood prone areas with relocation of homes and improvements; (3) floodproofing of buildings and other improvements and, as in Alternative No. 2, change in agricultural land use and applying land treatment; (4) altering the existing floodwater diversion protecting Van Horn or constructing a new

floodwater diversion and as in Alternative No. 2, changing the agricultural land use in the flood prone area and applying land treatment; and (5) foregoing the implementation of a project. Studies indicate there are no alternative floodwater retarding structure locations or floodwater diversion alignments that will not impact upon archeological sites.

A discussion of each alternative follows:

Alternative No. 1 - Alternative No. 1 consisted of only applying the land treatment measures as proposed in the project action. The impacts of the application of land treatment measures are discussed under the "EFFECTS OF WORKS OF IMPROVEMENT" section. Average annual floodwater flood plain erosion, and indirect damages would be reduced from $161,060 to $152,820, or a reduction of 5.1 percent. The volume of sediment being delivered to Wild Horse Draw would be reduced from 13 acre-feet to 12 acre-feet annually, a reduction of about 8 percent. This alternative would have very little effect in reducing scour on the cultivated flood plain and in reducing the volume of sediment produced by this process. The adverse impacts that would be caused by installation of the structural measures would be eliminated as would be the favorable impacts. Effects on fish and wildlife from land treatment would generally be the same as the planned project. Elimination of existing vegetation on the areas to be disturbed by construction would be avoided. The estimated cost of this alternative is $190,300.

Alternative No. 2 - Alternative No. 2 consisted of changing the present use of irrigated agricultural land to a use less susceptible to damage by flooding, application of land treatment, and purchase of flood prone areas with relocation of homes and improvements.

The potential land uses, listed in order from highest to lowest susceptibility of flood damage, are urban and built-up areas, cropland, pastureland, and rangeland. Land used for other purposes, such as transportation systems and wildlife-recreation land, are damaged to varying degrees by flooding, depending upon the type of development and depth and duration of flooding.

In order to reduce the need for flood protection, it would be necessary to relocate 15 homes and associated improvements to assure flood-free protection to floor levels from a 100-year event within the urban area of Van Horn. It would also be necessary to move the city cemetery and change the land use on about 4,400 acres of land used for growing crops. The land could be used for rangeland or wildlife-recreation land, if extensive developments were not installed.

This alternative would reduce the actual monetary damage caused by floodwater, sediment, and erosion. The 95 homes for which relocation

is not considered would continue to suffer damage to foundations, yards, outbuildings, and similar properties. Changing the land use from cropland to rangeland would reduce the food supply for many species of wildlife that are present in the watershed. Damages to the transportation system would continue at approximately the same rate because it was determined to be impracticable to move the system out of the flood hazard area. The gross income to the owners and operators of the 4,400 acres of irrigated cropland would be reduced by about $1,431,850 annually, if the land use were changed to rangeland. In addition, if the land was purchased or diverted by government action, tax revenues lost to the county and school district would be about $5,400 annually. The concentration of sediment in runoff leaving the watershed would continue at about 5,600 milligrams per liter.

The relocation of 15 residences and the city cemetery would require changed land use on the land needed for relocations. The use of 1,781 acres of land for installation and functioning of the structural measures and the resultant adverse impacts would be eliminated. The need to remove existing vegetation on areas to be disturbed by construction would be eliminated.

The application of land treatment measures and resultant effects on areas presently being used as rangeland and on about 3,900 acres of irrigated cropland would be essentially the same as in the proposed project action. The 4,400 acres of cropland requiring conversion to rangeland would need application of land treatment measures such as range seeding, proper grazing use, and deferred grazing. Livestock fences and watering facilities would also be needed. Wildlife upland habitat management would also be practiced to assure minimum adverse effects on wildlife in the area. The major impacts on wildlife would be a reduction in the seasonal food source from grain sorghum, and the increase in cover provided by perennial and annual vegetation that would be established. Point sources of water would be reduced with the reduction of cropland irrigation; however, with the installation of livestock watering facilities adapted for wildlife use, more dependable sources of water on a year-round basis would become available.

The cost for implementing this alternative is estimated to be $2,127,830 of which $162,830 are for land treatment; $1,650,000 are for agricultural land acquisition; and $315,000 are for relocation of residences and the city cemetery in Van Horn.

The gross average annual benefits from implementation of this alternative are estimated to be $4,850.

Alternative No. 3 - This alternative consisted of floodproofing existing buildings and improvements and, as in Alternative No. 2, changing the land use on irrigated agricultural land in the flood hazard area and applying land treatment.

Early in planning it was recognized by the sponsors and project planners that if floodproofing of improvements in the urban area of Van Horn and the cemetery was to be accomplished, it would behoove all concerned to disregard the function of the floodwater diversion constructed by the railroad company. The diversion is constructed of uncompacted earth materials and has received a minimum of maintenance. It has been demonstrated by the 1966 flood that a storm with a 25-year recurrence interval will cause floodwater to flow over the top of the diversion. Considering the method of construction, materials used, and amount of maintenance, a storm with an expected reccurrence interval of 25 years or more would subject the diversion to failure. It is conceivable that a diversion failure would channel floodwater into the urban area, causing greater damage than if there were no diversion (see drainage patterns on figure 1 or figure 5).

A reconnaissance-type survey of urban properties indicated that floodproofing could be accomplished on most of the improvements subject to flood damage above floor level. This would include preventive measures and construction dikes or levees around brick, stucco and other non-movable structures or installations, and elevating frame or movable structures.

The cost of floodproofing that will provide flood free protection to floor levels from a 100-year recurrence interval flood (one percent chance) is estimated to be $45,000. The impacts and cost of changing the use of the irrigated agricultural land and applying land treatment would be the same as in Alternative No. 2. The effects on wildlife would be essentially the same as Alternative No. 2. Average annual benefits from this alternative would be the same as those from Alternative No. 2.

Alternative No. 4 - This alternative consisted of altering the existing floodwater diversion or constructing a new floodwater diversion and, as in Alternative No. 2, changing the use of irrigated agricultural land in the flood prone area and applying land treatment.

Engineering investigations and studies indicate it would not be feasible to increase the height of the existing floodwater diversion to provide additional flood protection. As previously stated, the diversion is constructed of uncompacted earth materials and has received a minimum of maintenance. These conditions would require extensive alterations be made before additional flood protection to the urban area of Van Horn could be effected. In fact, to provide a dependable floodwater diversion that would protect the urban area from a flood with a 100-year recurrence interval, it would be necessary to completely rebuild the existing diversion or construct a new one.

To alter the existing diversion or construct a new floodwater diversion would require 220 acres of land. Under present conditions, there would be no displacement or relocation of farm and ranch operations, businesses, or individuals. The impacts on vegetation and wildlife in the 220 acre area required would be essentially the same as those described for installation of the proposed floodwater diversion in the project. The monetary input for construction is estimated to be $600,000. The impacts and cost of changing the use of the agricultural land would be essentially the same as Alternative No. 2. The effects on wildlife would be essentially the same as Alternative No. 2. Existing vegetation in the area needed for levee construction would be eliminated. Average annual benefits from implementation of this alternative would be the same as those from Alternative No. 2.

Alternative No. 5 - Alternative No. 5 consisted of foregoing the implementation of a project.

Foregoing any type of project action would result in continued flood damage to agricultural and urban areas. There would be a reduction in priority of technical assistance to watershed land users for all segments of land treatment. This would have an adverse effect on grassland ecosystems and reduce the ability of these ecosystems to support a livestock industry. Wildlife resources would also be adversely affected.

Irrigation systems on cropland would continue to be damaged by recurring floods and improvements to existing systems would not be feasible without flood protection. Operation of marginal and inefficient irrigation systems results in waste of ground water and reduces agricultural production. Erosion and resultant sediment deposition would continue.

The need to use 1,781 acres of land for the installation and functioning of the structural measures and the resultant impacts would be eliminated.

The opportunity to realize about $103,220 in average annual net benefits would be foregone.

It was apparent in the early stage of planning that adequate control of the watershed above the irrigated cropland could not be obtained by floodwater retarding structures alone. Favorable topographic site conditions for necessary storage in floodwater retarding structures were found only above State Highway 54. Below this highway, the channels of all tributaries to Wild Horse Draw tend to be undefined, and the topography is gently sloping without defined hills or ridges. Under these conditions, adequate storage could be obtained only by long embankments requiring unusually large surface areas. Excessive costs of such structures led to consideration of a floodwater diversion in combination with floodwater retarding structures.

Six sites for floodwater retarding structures and approximately 55,000 feet of floodwater diversion were considered to determine and select the least costly system needed to provide the agreed upon level of protection. In selecting sites for structural measures, consideration was given to locations which would provide maximum protection to areas most subject to damage. Topographic, geologic, hydrologic, and other physical features had considerable influence upon the size, number, design, and cost of structures included in the plan. Man-made impressions of archeological significance in the bedrock near the stream channel of Three-Mile Draw were considered in locating Floodwater Retarding Structure No. 2 for the final plan.

The possibility of a floodwater retarding structure on Sulfur Draw about 0.8 of a mile above the irrigated cropland was studied. It was determined that in addition to exorbitant installation costs, a large area would be required for embankment construction and temporary floodwater storage. These factors dictated the omission of this potential structure site from further consideration.

Three floodwater retarding structures on unnamed tributaries between Three-Mile Draw and Sulfur Draw were considered and evaluated. It was determined their effectiveness in curtailing damages on cropland and rangeland, or reducing peak flows and design requirements at the floodwater diversion would be insignificant. Therefore, these structures were not incorporated into the final project plan.

Floodwater Retarding Structure No. 1 on Sulfur Draw, Floodwater Retarding Structure No. 2 on Three-Mile Draw, and 55,000 feet of floodwater diversion were selected for inclusion in the final project (figure 5). This system of structures, which will achieve project objectives for flood prevention, requires commitment of less physical resources and is the least costly system considered.

At the request of the city of Van Horn, investigations were made to determine the feasibility of providing recreational water storage for the City and surrounding area in Floodwater Retarding Structure No. 2. This site has physical features for adequately storing additional water for beneficial use. It was also determined that recreational water could be supplied by a multiple-purpose structure at this site. The basic site information for recreational and floodwater storage with basic recreational facilities was reviewed with the sponsoring local organization. After considerable evaluation, the sponsors decided not to include recreation water storage as a purpose. Financial limitations, limited sources of revenue and costs for additional operational responsibilities and basic facilities were the major reasons for excluding recreational water storage.

Alternatives for similar watershed protection and flood prevention in the watershed without the technical and financial assistance provided under the authority of Public Law 566 are nonexistent at the present

time. The burden of funding planning and construction entirely from local financing would preclude the initiation of such a project.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment

Conservation of soil, water, and plant resources is the basic element of a watershed protection and flood prevention project. Treatment and use of land within the watershed largely determines the degree to which conservation objectives are attained. The function and useful life of structural measures such as floodwater retarding structures and floodwater diversions are directly dependent upon the adequacy of conservation measures applied to the upstream land resource.

Conservation land treatment consists of individual measures and practices or a combination of measures and practices that are planned, installed, and maintained on privately owned land by individuals or groups of land users or by local organizations. These measures are applied on a voluntary basis with needed technical assistance from agencies having assigned responsibility in natural resource conservation. Most land users realize the necessity of applying conservation measures to conserve the natural resource base on which their livelihood depends. Application of land treatment measures provides increased income for present land users and protects basic resources for the use of future generations. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the planned structural measures, reduce flooding, and preserve or improve wildlife resources of the watershed.

Conservation land treatment applied and to be applied in this watershed will be on privately owned lands. The land user will make the decision on the use of his land and the treatment measures which he will install.

In addition to effectively maintaining land treatment measures already established (table 1A), it is planned to establish or complete the installation of needed land treatment measures on about 5,600 acres of cropland, 20,800 acres of rangeland, and 20 acres of pastureland. These land treatment measures are to be applied during a five-year installation period. With the installation of the planned land treatment, 88 percent of the watershed will be adequately treated. Land is considered to be adequately treated when conservation measures essential to its protection and planned improvement have been applied.

Conservation measures to be applied on cropland include conservation cropping systems, crop residue use, irrigation water management, irrigation land leveling, irrigation systems, and diversions.

Conservation cropping systems involve growing crops in combination with needed cultural and management measures that reduce erosion and protect

the soil. Crop residue management utilizes plant residue left on or near the soil surface to protect cultivated lands during critical erosion periods. Irrigation land leveling is the reshaping of the land surface to be irrigated to planned grades. Irrigation systems involve the installation of water control structures for the efficient distribution of irrigation water. Irrigation water management is accomplished by determining and controlling the rate, amount, and timing of irrigation water application to soils to supply plant water needs in a planned and efficient manner. A diversion is a channel with a supporting ridge on the lower side constructed across the slope of a field and is designed and located to protect land from erosion producing storm runoff from adjacent areas.

Conservation measures which will be applied on pastureland include the planting or seeding of adapted species of perennial forage plants and their management for sustained production and use.

Rangeland will be managed to maintain or improve existing vegetation conditions. Conservation measures to be applied on rangeland include proper grazing use, deferred grazing and planned grazing systems; and wells, troughs, and pipelines for livestock water. Proper grazing use, planned grazing systems, and deferred grazing are range management practices which involve the grazing of forage plants at periods of time and at intensities which are compatible with the physiological needs of plants. Application of these practices assures the continued growth and survival of desired plant species.

Wildlife upland habitat management will be applied on 8,800 acres of rangeland which is used as wildlife-recreation land. About 70,000 acres of land within the watershed will be managed for domestic livestock and wildlife use. Wildlife upland habitat management will consist primarily of protecting plants which have value to wildlife from overuse by domestic livestock. This will be done by limiting the number of livestock on areas where they would compete with wildlife for forage. To help assure adequate food supplies for deer, it is particularly important that any grazing by domestic sheep be minimized. Longer periods of deferred grazing by livestock will also be instrumental in wildlife upland habitat management. Land users who install or relocate livestock watering systems will be encouraged to construct them in a manner which will furnish water for livestock and wildlife.

Land users will continue to install and maintain conservation measures needed in the watershed following the installation period.

Structural Measures

A system of two floodwater retarding structures and approximately 55,000 feet of floodwater diversion will be constructed in the Three-Mile and Sulfur Draw Watershed. Figure 2 shows a section of a typical floodwater retarding structure. Figure 3 and 3A include a general plan and profile,

plan of reservoir, and cross section of a zoned embankment typical of the type of floodwater retarding structures included in this work plan. Elevations, stations, dimensions, etc. shown on figures 3 and 3A are for illustrative purposes only and do not apply specifically to the floodwater retarding structures planned in this watershed. Figure 4 shows a typical cross section of a floodwater diversion. Figure 4A is the plan view of the floodwater diversion included in the work plan. The locations of all the structural measures to be installed are shown on the Project Map (figure 5).

A floodwater retarding structure is an earth dam or embankment with a principal spillway and plunge basin, an emergency spillway, a floodwater retarding pool, and a sediment pool. The function of the embankment is to temporarily impound floodwater upstream in the retarding pool. The water in the retarding pool flows, during a predetermined period, through the principal spillway which is a concrete vertical inlet and conduit through the base of the embankment. Principal spillway flow is released into a plunge basin on the downstream side of the embankment. The plunge basin dissipates the energy of the principal spillway flow. The emergency spillway is designed to convey runoff that exceeds the planned capacity of the floodwater retarding pool past the embankment and back to the stream channel. The sediment pool is capacity below the principal spillway elevation allocated for storage of sediment expected to accumulate during a 100-year period.

The planned floodwater retarding structures will temporarily store or retard an average of 1.52 inches of runoff from 36.08 square miles of drainage area. These structures will control runoff from approximately 24 percent of the watershed. The total storage capacity of the floodwater retarding structures is 3,645 acre-feet, of which 720 acre-feet are for sediment storage and 2,925 acre-feet are for floodwater retarding storage. Tables 1, 2, and 3 show details on quantities, cost, and design for each floodwater retarding structure.

The floodwater retarding structures are designed to store submerged and aerated sediment. Crests of the principal spillways will be set at the elevation of the 100-year sediment pool. Principal spillways for both structures will be ported, as required by Texas Water Rights Statutes, at elevations which will limit each impoundment to 200 acre-feet including borrow. This will initially provide a total of 400 acre-feet of storage capacity below the lowest ungated spillway openings. Both floodwater retarding structures will have provisions to release impounded water in order to perform maintenance, and if it becomes necessary, to avoid encroachment upon any downstream water rights as may be granted by the Texas Water Rights Commission.

According to the "Catalog of Water Oriented Data, Volume 23, Rio Grande Basin, 1972," compiled by the Water Oriented Data Programs Section of the Interagency Council on Natural Resources and the Environment, there are no water rights permits issued for use of watershed runoff.

Major factors which will affect construction of both floodwater retarding structures will be rock excavation in emergency spillways, zoning of available borrow material within embankments, lack of suitable quantity of borrow material at the sites where the structures are to be constructed, and lack of adequate on-site supply of water for construction. Permeable zones of gravel within the embankment foundation will also affect construction of Floodwater Retarding Structure No. 2.

Floodwater Retarding Structure No. 1 will be located on the Hazel Formation. Conditions at the site are such that for practical purposes the structure's foundation will be entirely on bedrock. The rock in the immediate area of the site is a slightly metamorphosed, very fine-grained, massive, indistinctly bedded, maroon sandstone. This sandstone has been faulted approximately 0.3 mile downstream and 0.7 mile upstream from the centerline of the dam. The faults trend generally in a northwest-southeast direction. Calcite-filled joints and cracks are present in the immediate area of the site. These conditions are not expected to cause unusual construction problems. However, embankment drainage measures have been included for the structure.

The principal spillway will be a monolithic rectangular reinforced concrete inlet and a prestressed concrete-lined steel cylinder pipe outlet barrel on a noncompressible bedrock foundation. The pipe outlet barrel will discharge overflow into a rock-lined plunge basin. The lowest ungated outlet of the principal spillway is designed at the 200 acre-feet elevation of the sediment pool. No allowance was made for borrow in determining this elevation because little or no earth materials are available in the sediment pool.

Suitable borrow material for the dam is very limited in the sediment and retarding pool areas of Floodwater Retarding Structure No. 1. A small amount of gravelly terrace material (remnant of the Leona Formation) is located upstream from the site but it is so limited in quantity it is insignificant for construction purposes. It will be necessary to obtain fine-grained material downstream from the site. Auxiliary borrow areas totaling 66 acres are located about 1.5 miles downstream from the site. This area will furnish, as classified with the Unified Soils Classification System, sandy and gravelly, calcarious clay (CL) with lesser amounts of clayey gravel (GC).

It is estimated that 100 percent of the required excavation in the emergency spillway area, 38,640 cubic yards, will classify as rock. This material will be used as a rock blanket on the embankment.

The material at finished grade in the entire emergency spillway area will be erosion-resistant rock. The principal spillway capacity and floodwater detention storage will provide a one percent chance for emergency spillway use.

Streamflow to the site of Floodwater Retarding Structure No. 1 is considered to be ephemeral. There are some very small springs or seeps

upstream that yield a minimal amount of water. However, most of this yield is lost to evaporation.

The Van Horn Sandstone crops out in the abutments on the site of Floodwater Retarding Structure No. 2. However, much of the bedrock is covered with alluvial and colluvial material. On the right abutment, the unconsolidated material ranges in size from clay to large boulders. This material will have to be removed to insure stability of the dam near the right abutment. The valley floor and flood plain are covered with deposits of lenticular fine grain sand, silty sand and gravel, and sandy clay. Stratigraphic investigations with a portable seismograph indicate these deposits are between 15 feet and 40 feet thick. These materials in the foundation area of the dam have low settlement potential and high shear strength. Due to the permeable nature of these soil materials, foundation drainage measures were incorporated into the structure design to control seepage and possible excessive pore pressures. Bedrock (Van Horn Sandstone) crops out in the lower elevations of the left abutment, but is obscured by approximately seven feet of Quaternary terrace deposits on and near the top of the hill and emergency spillway area.

Approximately 27 percent of the 192,200 cubic yards of required emergency spillway excavation will classify as rock. By using selective placement and zoning, this rock and the common sandy clay (CL), silty sand (SM), and silty gravel (GM) material will be suitable for embankment fill. The material at finished grade in the control or crest section will be erosion resistant sandstone bedrock. The material at finished grade in the exit channel will consist of sandy and silty clay (CL), silty sand (SM), and clayey gravel (GC). The principal spillway capacity and floodwater retarding storage will provide a one percent chance for emergency spillway use.

The sediment pool area will yield an estimated 195,000 cubic yards of sandy, silty clay (CL), clayey sand (SC), and silty gravel (GM). An auxiliary borrow area of about 20 acres approximately 0.5 mile downstream from the centerline of the embankment is available and will furnish ample materials similar to those in the sediment pool.

The principal spillway for Floodwater Retarding Structure No. 2 will be a monolithic rectangular reinforced concrete inlet, and a prestressed concrete-lined steel cylinder pipe outlet barrel on a compressible soil foundation. Principal spillway flow will discharge into a rock-lined plunge basin.

The sediment pool of the structure will initially impound 200 acre-feet of water below the lowest ungated outlet of the principal spillway. It is anticipated that removal of earth fill materials from the sediment pool for the dam will create 31 acre-feet of the total 200 acre-feet capacity.

Streamflow above and below the site is ephemeral.

The lack of sufficient earthquake data makes it practically impossible to predict the magnitude and frequency of earthquakes. However, special considerations were made in the planning and designing of the earth dams. The emergency spillways have adequate capacity to pass flows created by major landslides into the reservoirs. Protection against dam failures caused by cracking will be achieved by selectively placing the soil materials for the dam and proper foundation preparation. The materials most resistant to piping will be placed in the center zone of the dams, and materials that lend themselves to sealing and controlling leakage will be placed in large transition zones downstream from the center zone.

Sufficient volumes of surface water for construction purposes are not available in the watershed or surrounding area, therefore, it will be necessary to use ground water. Ground water supplies should be adequate considering there are numerous wells in the area supplying water for cropland irrigation. A flooded, abandoned copper mine about 2.5 miles upstream from the centerline of Floodwater Retarding Structure No. 1 is another possible source of water for construction. Water from the mine would be either hauled or pumped through pipe to the floodwater retarding structure site where it would be sprinkled on soil materials as they are placed on the dam under construction. Water is needed in conjunction with mechanical rollers to obtain the most desirable degree of compaction of soil materials to be used in the dams. Water will also be sprinkled as needed on haul roads, excavation areas, etc. to suppress dust. The means of transport, quantity needed, and the application and use will not cause stream pollution from water that is probably contaminated with acid mine wastes.

Floodwater Retarding Structures Nos. 1 and 2 will have the capacity at the lowest ungated outlets to impound 17 and 31 surface acres of water respectively. The quality of water impounded is anticipated to be adequate for fish habitat. However, due to a low amount of annual precipitation, high evaporation rate, and anticipated filling of the pools with sediment, the impoundments are not expected to be dependable habitat for a fisheries resource. Water budget studies made during planning yielded data which supercedes the "preliminary data" referred to by the Fish and Wildlife Service. The water budget studies data indicate the sediment pools will initially contain sufficient water to be suitable fish habitat on an average of two out of every five years. The two years with suitable habitat will not necessarily be consecutive. It is possible the sediment pools will be completely dry during times of drought. The depletion of the pools' capacities by sediment accumulations will further reduce the dependability of suitable fish habitat.

It is anticipated that stocking of the floodwater retarding structures' sediment pools will not be feasible or practical in view of the expected frequency with which fish populations will be lost due to inadequate water supplies.

Presently the sponsoring local organization has no plans for developing a fishery or any kind of recreational facility at either of the floodwater retarding structure sites, and do not intend to provide public access to the sites. Present conditions and plans do not warrant the installation of sanitary facilities; however, prior to any public use of water that might be impounded at some future time, the sponsors will provide adequate sanitary facilities approved by the Texas Health Department and appropriate local health agencies.

Installation of floodwater retarding structures will require a change in location or modification of known existing improvements as follows: county road at Site No. 2; private roads at Sites Nos. 1 and 2; and fences at Site No. 2. All costs for necessary changes of location or modifications as listed will be borne by the sponsoring local organization.

The floodwater diversion will consist of excavation and semi-compacted earth fill approximately 55,000 feet in length. It will have a bottom width of 60 feet and the depth of excavation will average about 4.0 feet. The entire length of floodwater diversion will have 4:1 slopes in the excavated and levee portion of the diversion.

Tables 1, 2, and 3A show quantities, cost, and design of the floodwater diversion.

The material through which the floodwater diversion will be excavated consists of clay, silt, silty sand, clayey gravel, and silty gravel.

Two sections of the diversion are designed to control the locations of overtopping and breaching when storm events occur creating runoff in excess of the diversion's capacity. These sections, located at stations 198+00 and 315+00 (figure 4A), will be approximately 100 feet in length and have a top elevation 0.5 foot less than that of the diversion on each end of the sections.

Included as an integral part of the floodwater diversion is a small protective levee, around a ranch headquarters (figure 4A, station 170+20), which will provide protection for the ranch headquarters from storm runoff being conveyed by the floodwater diversion. This small levee will have a maximum height of three feet and is designed with a drainage pipe and a flap gate. This protection will extend to an elevation of 3763.7 feet mean sea level or to at least the elevation of the top of the floodwater diversion, whichever is greater.

Water discharged from the diversion will flow on to a broad flat area presently being used as rangeland. The discharge will flow generally in an east north-easterly direction for about two miles and confluence with Wild Horse Draw (figure 4A). Soil materials in the area are mostly clay and silty clay with minor amounts of sandy and gravelly clay.

Installation of the floodwater diversion will require a change of location or modification of known existing improvements as follows: fencing, private ranch road, and county road. All costs for necessary changes of location or modifications as listed will be borne by the sponsoring local organization.

Areas requiring soil erosion control as a result of construction of the floodwater retarding structures and diversion will be protected by the use of rock riprap and gravel blankets. It is anticipated that materials for rock riprap will be available from on-site locations. However, gravel material may have to be obtained from commercial sources.

Due to climatic conditions, it is impractical to plan vegetative measures on structures for erosion control. Low average annual rainfall (about 10 inches) and high temperatures (atmospheric and soil) are the principal factors. It is not uncommon for temperatures during the summer to exceed 100 degrees Fahrenheit. When atmospheric temperatures rise to this degree, soil temperatures can be expected to exceed 145 degrees Fahrenheit. These temperatures are far above the 110 to 120 degree range at which seedlings usually die. During the winter months seasonal precipitation is generally lower, creating an adverse condition insofar as available soil moisture is concerned. If vegetation was established under conditions of above average rainfall or with irrigation, it could not be expected to be dense enough to effectively control erosion. Under climax or excellent conditions in this area, the distance between plants ranges from 8 to 24 inches.

All applicable state laws will be complied with in the design and construction of all structural measures as well as those pertaining to the storage, maintenance of quality, and use of water.

During construction, contractors will be required to adhere to strict standards set forth in each construction contract to protect the environment by minimizing soil erosion, and water and air pollution. These standards will be in compliance with U.S. Department of Agriculture, Soil Conservation Service Engineering Memorandum 66, "Guidelines for Minimizing Soil Erosion and Water and Air Pollution During Construction." Excavation and construction operations will be scheduled and controlled to prevent exposure of extraneous amounts of unprotected soil to erosion and the resulting translocation of sediments. Measures to control erosion will be uniquely specified at each work site and will include, as applicable, use of temporary vegetation or mulches, diversions, mechanical retardation of runoff, and traps. Harmful dust and other pollutants inherent to the construction process will be held to minimum practical limits. Haul roads and excavation areas, and other work sites will be sprinkled with water as needed to keep dust within tolerable limits. Contract specifications will require that fuel, lubricants, and chemicals be adequately labeled and stored safely in protected areas, and disposal at work sites will be by approved methods and procedures. Clearing and disposal of brush and vegetation will be

carried out in accordance with applicable laws, ordinances, and regulations in respect to burning. Each contract will set forth specific stipulations to prevent uncontrolled grass or brush fires. Disposal of brush and vegetation will be by burying, hauling to approved off-site locations, or controlled burning, as applicable.

Stringent requirements for safety and health in conformance with the Construction Safety Act will be included in each construction contract.

Necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such facilities from being a pollution hazard to live streams, wells, or springs in conformance with Federal, State, and local water pollution control regulations. Special provisions in each construction contract will incorporate by reference, and thereby make the contract provisions conform to "Safety and Health Regulations for Construction, Part I and Part II," U.S. Department of the Interior, Bureau of Reclamation. Soil Conservation Service guidelines that provide for the incorporating of the Bureau of Reclamation regulations into construction contracts are in the "Soil Conservation Service Administrative Services Handbook, Chapter 6." Conformance to all environmental control requirements will be monitored constantly by a construction inspector who will be on-site during all periods of construction operation.

The watershed work plan has been coordinated with the Texas State Historical Commission and the National Park Service, USDI. The installation of the project will not encroach upon any known historic places or any planning for historic preservation by the Commissioners.

Investigations by the Archaeology Research Program, Southern Methodist University, indicate that construction of the structural measures included in the project will affect eight archeological sites, none of which are considered eligible for nomination to the National Register of Historic Places. Three other sites, not considered eligible for nomination, are located within the area surveyed but will not be affected by construction or inundation.

Two archeological sites designated X41CU3 and X41CU9 will be affected by Floodwater Retarding Structure No. 1. Two archeological sites designated X41CU10 and X41CU11 will be affected by Floodwater Retarding Structure No. 2. Site X41CU11, is not located within the construction or pool area. However, it could be accidentally disturbed by movement of construction equipment unless proper precautions are taken. The site will be prominently flagged to prevention encroachment by construction equipment and personnel. Four archeological sites designated X41CU1, X41CU6, X41CU7, and X41CU8 will be affected by construction of the floodwater diversion.

Investigating archeologists recommend that no further work be undertaken at these sites. This recommendation is concurred in by the State Historic Preservation Officer.

The unpublished reports, "Prehistoric Archeology in the Three-Mile and Sulphur Draw Watershed" November 1973 and "Prehistoric Settlement in the Three-Mile and Sulphur Draw Watersheds," October 1975, Archaeology Research Program, Department of Anthropology, Southern Methodist University, contain additional details relative to the archeological sites surveyed. These reports are available for review at the State Office, Soil Conservation Service, First National Bank Building, Temple, Texas 76501.

If cultural values are discovered during construction, the Soil Conservation Service will immediately consult with the National Park Service to determine whether there is substantive factual evidence to warrant a decision to undertake detailed surveys and recovery. If the evidence is substantive, and at the request of the National Park Service, construction will be stopped to undertake immediate surveys and recovery. If the evidence is inconclusive, construction will continue with caution.

Land Rights

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the works of improvement; to provide for flowage of water in, upon, or through the structures; and provide for the permanent storage and temporary detention, either or both, of any sediment or water.

Under present conditions, no farm or ranch operation, business, or person will be displaced by installation of the planned floodwater retarding structures and the floodwater diversion. However, if relocations or displacements become necessary, they will be carried out in compliance with Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

A total of 1,781 acres of land will be needed for installation and proper functioning of the floodwater retarding structures and floodwater diversion. The dams and emergency spillways will require 78 acres; sediment pools, 68 acres (48 acres below the lowest ungated outlets); floodwater retarding pools, 239 acres; and auxiliary borrow areas, 86 acres. The floodwater diversion will require a total of 1,378 acres. The diversion will be installed on 382 acres. Flowage easements will be obtained on 996 acres. Of this 996 acres, 346 acres will be above and adjacent to the diversion and 650 acres will be between station 0+00 and Wild Horse Draw (figure 4A).

Approximately 594 acres will be cleared of all existing woody vegetation for the construction of dams (included are 86 acres for auxiliary borrow areas), emergency spillways, sediment pools below the lowest ungated outlets, and the floodwater diversion. Except for occasional and temporary inundation, the 191 acres to be used for sediment reserve and floodwater retarding pools will not be disturbed. The vegetation on 996 acres on which flowage easements will be obtained will not be disturbed

during construction. However, this area will be subject to occasional inundation.

The 1,781 acres required for construction and functioning of the structural measures are primarily rangeland in poor condition. The dominant vegetation is creosotebush and lecheguilla.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures will be applied by local interests at an estimated cost of $190,300 (table 1). This includes approximately $19,000 of Public Law 46 funds to be provided by the Soil Conservation Service under the going program for technical assistance during the five-year installation period. The costs of application of the various measures and practices are based on present prices being paid by landowners and operators in the area.

The total installation cost of the structural measures is estimated to be $1,102,790, of which $1,058,340 will be borne by Public Law 566 funds, and $44,450 by local interests.

The Public Law 566 costs for installation of structural measures are $885,540 for construction, $44,280 for engineering services, and $128,520 for project administration.

The local costs for installation of structural measures are $44,450 which includes $33,760 for value of land; $2,100 for modification or change in location of private and county roads; $3,090 for modification or change in location of fences and water gaps; $3,500 for legal fees; and $2,000 for project administration.

Construction costs include the engineer's estimate and contingencies. The engineer's estimate was based on unit cost of structural measures in similar areas modified by special conditions inherent to each individual site location. Included are such items as permeable foundation, special placement of soil materials in the dams, rock excavation in emergency spillways, need for location of auxiliary borrow areas, and scarcity of on-site water supplies for construction purposes. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs.

Engineering services and project administration costs were based on an analysis of previous work in similar areas. Engineering services costs consist of, but are not limited to detailed surveys, geologic investigations, laboratory analysis of soil materials, reports, designs, and cartographic services.

Public Law 566 project administration costs consist of construction inspection, contract administration, and maintenance of records and accounts.

The local costs for project administration includes sponsors' cost related to contract administration, overhead and organizational administrative costs, and whatever construction inspection they desire to make at their own expense.

The costs of land rights were determined by appraisal in cooperation with representatives of the sponsoring local organization.

The following is the estimated schedule of obligations for the five-year installation period:

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	-	29,870	29,870
Second	Land Treatment	-	25,120	25,120
	Structure No. 2	427,080	5,250	432,330
Third	Land Treatment	-	36,920	36,920
	Structure No. 1	311,530	2,660	314,190
Fourth	Land Treatment	-	55,190	55,190
	Floodwater Diversion	319,730	36,540	356,270
Fifth	Land Treatment	-	43,200	43,200
TOTAL		1,058,340	234,750	1,293,090

This schedule may be changed from year to year to conform with appropriations, accomplishments, and any mutually desirable changes.

EFFECTS OF WORKS OF IMPROVEMENT

The installation of the planned conservation land treatment measures, two floodwater retarding structures, and 55,000 feet of floodwater diversion will achieve the project objectives of watershed protection and flood prevention.

Eighty-eight percent of the watershed will have received conservation land treatment measures essential to its protection. Average annual reduction of flood damage to agricultural flood prone lands will exceed the 70 to 75 percent objective. Flood damages resulting from all flood events up to and including a predicted 100-year event will be eliminated.

Land Treatment

The installation of conservation land treatment measures on 26,420 acres of land in addition to effectively maintaining those already applied will protect soil, water, and related resources by preventing soil erosion, reducing water pollution by sediment, conserving irrigation water, increasing infiltration, and reducing runoff. Land users in the flood prone land will be able to improve their management of the area with application and use of additional land treatment measures after a reduction in flooding is effected.

Conservation cropping systems and crop residue use will provide soil protecting cover which will help improve or maintain soil productivity and tilth. Crop residues which are properly managed increase the ability of soils to retain moisture and reduce the loss of organic matter and nutrients. Irrigation water management and irrigation land leveling provide for more efficient use of irrigation water and prevent erosion through application of the water.

The application of pastureland treatment measures including pasture planting and proper management will protect the soil and decrease the rate of runoff by providing a good ground cover on this intensively used land.

The application of rangeland treatment measures, including proper grazing use, planned grazing systems, and deferred grazing, will increase the productivity and density of desirable grasses and forbs normally found in the natural plant community. Increasing the density of grasses and forbs will reduce erosion by improving the protective cover from poor and fair condition to fair and good condition. This will improve forage conditions for livestock and habitat for wildlife in the watershed. Wells, pipelines, and troughs installed for watering livestock will reduce livestock travel and distribute grazing to prevent overuse of vegetation near sources of water and under-utilization of vegetation at greater distances from water.

After the project is complete, the level of accomplishment for needed land treatment is expected to reach 88 percent, a 36 percent increase over present conditions.

Application of the planned land treatment is expected to reduce annual gross erosion from 92,500 tons to 85,760 tons, a reduction of approximately seven percent.

Structural Measures

When the project is complete, annual erosion damage to 840 acres in the flood prone area is expected to be reduced 86.4 percent. A 90.5 percent reduction in sediment deposition damage on 385 acres will be effected. The average annual sediment yield from the watershed to Wild Horse Draw

will be reduced from 13 acre-feet to five acre-feet. The concentration of sediment in 0.76 centimeter of average annual watershed runoff will be reduced from 5,600 to 1,600 milligrams per liter, a 71.4 percent reduction.

Flood protection will be provided to 13,200 acres of flood plain land within the watershed and will benefit directly the owners and operators of approximately 15 farms and ranches in the flood plain and the owners and occupants of 110 residential units. In addition, land users of land along Wild Horse Draw adjacent to and downstream from the watershed will receive some benefits from the project. Indirect benefits include the reduction or elimination of expenses associated with interruption or delay of travel, rerouting of school busses and mail routes, disruption of farm operations, business losses in the area, and similar losses.

After installation of the combined program of land treatment and structural measures, average annual flooding will be reduced from 1,515 acres to 50 acres, a reduction of 96.7 percent.

Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas to be benefited as a result of reduced flooding, caused by the combined program of land treatment and structural measures are presented in the following tabulation:

Evaluation Reach (figure 1)	Location	Average Annual Area Inundated: Without Project (acres)	With Project (acres)	Reduction 1/ (percent)
1	Urban Area-City of Van Horn	5	0	100
2	Agricultural Area	1,510	50	97
TOTAL		1,515	50	97

1/ Reduction based on consideration of floods up to and including the 100-year frequency event.

The number of acres inundated in each evaluation reach without and with the project by various frequency floods is presented in the following tabulation:

Area Inundated by Selected Recurrence Intervals

Evaluation Reach (figure 1)	Recurrence Interval: 2-Year Without Project (acres)	2-Year With Project (acres)	5-Year Without Project (acres)	5-Year With Project (acres)	25-Year Without Project (acres)	25-Year With Project (acres)	100-Year Without Project (acres)	100-Year With Project (acres)
1	0	0	0	0	0	0	200	0
2	560	10	2,860	60	5,960	190	8,840	290
TOTAL	560	10	2,860	60	5,960	190	9,040	290

Had the project been installed at the time of the 1966 flood, acres flooded would have been reduced from about 5,969 acres to 190 acres, a reduction of approximately 96.8 percent. Direct floodwater damages would have been reduced from an estimated $306,980 to $9,150, a reduction of 97.0 percent.

The following tabulation shows effects of the project on flood damages by evaluation reaches.

Average Annual Damage Reduction 1/

Evaluation Reach (figure 1)	Crop and Pasture (percent)	Other Agricultural (percent)	Non-Agricultural (percent)	Sediment (percent)	Flood Plain Erosion (percent)	Total (percent)
1	-	-	100.0	-	-	100.0
2	96.7	96.7	95.1	90.1	86.0	92.3
Weighted Average	96.7	96.7	97.9	90.1	86.0	92.5

1/ Reduction based on consideration of floods up to and including the 100-year frequency event.

Floodwater Retarding Structure No. 2 will complement the existing diversion above the city of Van Horn by providing protection from floods up to and including the 100-year frequency event. Presently this diversion is subject to overtopping by runoff from a storm with an expected recurrence interval of 25 years. With the installation of Floodwater Retarding Structure No. 2, the potential for overtopping and possible failure of the diversion will decrease significantly. The floodwater retarding structure will control runoff from 16,966 acres. Under without project

conditions, this runoff would either be controlled by the existing diversion or overtop the diversion possibly causing it to fail and become a menance to Van Horn. The residents of Van Horn, when Floodwater Retarding Structure No. 2 is constructed, will have an increased sense of security by knowing their lives and properties are more adequately protected from the threat of floodwaters.

A maximum initial reduction in average annual runoff of 60 acre-feet is expected from the effects of evaporation from sediment pools of the floodwater retarding structures. This will result in an initial reduction from 2,380 to 2,320 acre-feet, 2.5 percent, in average annual volume of watershed runoff. This initial water loss in the floodwater retarding structures will be reduced as sediment accumulates in the sediment pools over the life of the project. Most of the 60 acre-feet volume, however, can be expected to evaporate under present conditions on its way to or after it reaches Salt Basin.

During construction of the structural works of improvement, air and water pollution will increase slightly from dust and sediment inherent to the construction process. This increase will be kept within tolerable limits. At the end of construction and with the establishment of erosion control measures, the dust and sediment increase intrinsic to construction operations will have completely subsided.

The project will commit about 1,781 acres of agricultural land to the construction and functioning of the structural measures. All this land is rangeland. The dams, emergency spillways, and sediment reserve pools will require 78 acres; sediment pools below the lowest ungated outlets 48 acres; and the floodwater diversion 382 acres. These areas will be retired from agricultural production. Floodwater retarding pools will require 171 acres which will be subject to temporary inundation from time to time. An additional 996 acres will be needed for the conveyance of floodwater along and below the floodwater diversion. Soil materials on 86 acres of auxiliary borrow area will be subject to removal and use for construction of the dams.

The commitment of labor and material resources will be irretrievable.

Agricultural Water Management .

Irrigation systems and appurtenances on 15 farms in the Wild Horse farming area will be protected from floodwater originating in the watershed. The area will be secure from floods caused by a one percent chance (100-year) flood event. In addition to maintaining and improving systems now in use, land users can invest in new irrigation systems and equipment without fear of damage or destruction from erosion, sediment, and floodwater. Water impounded in the sediment pools of the floodwater retarding structures will be of excellent quality for irrigation uses. However, these sources of water are expected to be very unreliable. Low annual precipitation, high evaporation rates, and filling of the pools

with sediment are factors effecting this unstable condition. During times of drought when the need for water could be the greatest, the sediment pools will possibly be completely dry. The floodwater retarding structures are located about eight miles from the Wild Horse farming area. It would be highly speculative to invest in equipment to pump and convey water from these sources to where it would be utilized. In the event water from these sources should be used for irrigation, appropriate water rights permits, as required by Texas Water rights statutes, will be needed from the Texas Water Rights Commission.

Fish and Wildlife and Recreation

The effects of the works of improvement on fish and wildlife habitat are described by the Fish and Wildlife Service as follows:

> "With the project, there is a possibility that one or perhaps both floodwater retarding structures would hold water during non-drought years. Preliminary information suggests that significant year-round storage may occur on the average of every other year. With the scarcity of sport fishing in this semi-arid region, the Texas Parks and Wildlife Department would be willing to stock such an impoundment when conditions are at all favorable for fish survival. While less than ideal, the resulting fishery would provide significant sport fishing opportunities.
>
> If the reservoirs do not hold water during non-drought years, no fishing of any kind would result from the project.
>
> Without the project, future wildlife populations are expected to remain at about their present levels.
>
> With the project, the construction of floodwater retarding structures and the implementation of some land treatment measures are expected to improve wildlife habitat.
>
> The construction of the floodwater retarding structures periodically would provide new sources of water in an area where the shortage of drinking water is a limiting factor to many species of wildlife. Stable vegetative borders would become established along the more permanent pool levels and immediately below the dams where floodwater releases would encourage vegetative growth. The resulting vegetative cover would offer some wildlife refuge. Reservoirs retaining water during the spring and fall months would benefit waterfowl by providing resting areas during migration flights. The habitat of ground-nesting birds and other lowland game species would be improved below the floodwater retarding structure with the reduction in severity and frequency of floods.
>
> Land treatment measures that can be expected to enhance wildlife are deferred grazing, range seeding, and proper grazing use. Also

included would be construction of additional stock watering facilities. These practices would improve the general vegetative conditions, increase the number of available wildlife drinking points, and provide a better distribution of watering facilities through the project area.

An insignificant amount of wildlife habitat of minimal value would be destroyed with the construction of the floodwater retarding structures and the floodwater diversion structure."

The sediment pools at the elevations of the lowest ungated outlets will initially have the capability to impound 48 acres of water surface. Due to a low amount of annual precipitation, high evaporation rate, and anticipated filling of the pools with sediment, these impoundments are not expected to be a dependable habitat for a fisheries resource. It is possible these sediment pools will be completely dry during times of drought. However, the ecological diversity will be increased by the creation of temporary wetland habitat which presently does not exist in the area. When inundated, the 48 acres of area will be lost as upland wildlife habitat.

About 78 acres will be required for the construction of dams and emergency spillways. Vegetation on areas other than bare rock which presently serves as limited habitat for wildlife will be removed. The area needed for installation of the dam and emergency spillway of Floodwater Retarding Structure No. 1 is bare rock except for isolated areas of soil which support a sparce stand of yucca (Yucca spp.) and creosotebush. The dam and emergency spillway of Floodwater Retarding Structure No. 2 supports a sparce stand of creosotebush, yucca, lecheguilla, and catclaw (Acacia greggii). A maximum of 86 acres will be needed for auxiliary borrow areas. These areas presently support vegetation similar to that found on Floodwater Retarding Site No. 2.

The vegetative cover and the wildlife habitat value of the 171 acres in the floodwater retarding pools will undergo insignificant changes as a result of installation of the floodwater retarding structures.

Construction of the floodwater diversion will require 382 acres of rangeland. Vegetative cover and wildlife habitat value on this area will be destroyed during construction. Vegetation on the area to be affected is composed of a scattered stand of creosotebush, lecheguilla, broom snakeweed (Gutierrezia sarothrae), and mesquite. The predominant grasses are fluffgrass, tobosa, threeawns, hairy tridens, and annuals. Some annual weeds exist which provide food for scaled quail. Deer habitat is poor due to a lack of adequate cover in or near the vicinity of the proposed floodwater diversion. Estimated total vegetative production is less than 200 pounds per acre of which about 10 percent has forage value for livestock or wildlife.

With the exception of the 382 acres needed for construction and functioning of the floodwater diversion, the vegetation and fauna on the

intervening area between the planned floodwater retarding structures and the Wild Horse farming area are expected to experience only minor changes after construction. After installation of the floodwater diversion about 400 acres of this rangeland below the diversion, which has essentially the same vegetative composition as the 382 acres needed for construction, will be deprived of runoff they would have otherwise received. The principal effect of the reduction in moisture will be a lessening in density of grasses and weeds that are present. It is expected that this effect will extend to about 300 feet below the diversion and progressively decrease as distance increases from the structure. The reverse effect can be expected above the floodwater diversion; areas presently receiving small amounts of runoff will be subjected to relatively large quantities moisture. It is in these areas that vegetative density and quality will increase.

The 400 acres below the planned floodwater diversion are presently of minimal value as wildlife habitat. Impacts on wildlife in the area will be minor with the increase in vegetative density and quality above the diversion. With the prevailing climatic conditions, the availability of water is a principal factor determining the growth and reproduction of desirable plants providing habitat for wildlife. The diversion will concentrate runoff and overflow along a defined course, rather than over-land type flow, and provide more moisture which will result in higher quality habitat for wildlife in the area.

Archeological, Historical, and Scientific

Presently there are no known locations of historic significance in the watershed.

The immediate direct effects of construction operations on archeological resources, as appraised by the Archaeology Research Program, Southern Methodist University, and concurred in by the State Historic Preservation Officer are as follows:

Site No.	Effects
X41CU1	Will be disturbed by construction of floodwater diversion.
X41CU2	Will not be disturbed by construction of diversion.
X41CU3	Located within detention pool of Floodwater Retarding Structure No. 1. Will be subject to occasional inundation by floodwater.
X41CU4	Located above detention pool elevation of Floodwater Retarding Structure No. 2. Will not be affected by construction or inundation of water.

X41CU5	Located above detention pool elevation of Floodwater Retarding Structure No. 2. Will not be affected by construction or impoundment of water.
X41CU6	Will be disturbed by construction of floodwater diversion.
X41CU7	Will be disturbed by construction of floodwater diversion.
X41CU8	Will be disturbed by construction of floodwater diversion.
X41CU9	Will be disturbed by construction of the embankment of Floodwater Retarding Structure No. 1.
X41CU10	Partially located within detention pool of Floodwater Retarding Structure No. 2. Part of site will be subject to occasional inundation by floodwater.
X41CU11	Located below embankment of Floodwater Retarding Structure No. 2. The original centerline of the structure was relocated to avoid disturbing archeological site.

Economic and Social

The application of the planned land treatment will result in more efficient use of irrigation water, cropland, and grassland. This will improve farm and ranch income.

Secondary benefits to the local area resulting from the project include requirements for additional seed, petroleum products, and repair services annually. New fencing will be required for proper management of grassland.

Increased agricultural efficiency will be realized by operators of land that will become more productive after damaging floods, sediment, and scour have been alleviated. The reduction of damages by structural means will provide an impetus for a higher quality of living and social upgrading. The project will create some additional employment for local residents. The firms contracting for installation of the structural measures will employ some of their employees locally. The increased needs of the entire economy will create the equivalent of 20 permanent jobs for local residents. 1/ The operation and maintenance of the

1/ Estimated from an adaptation of An Input-Output Analysis of the Texas Economy Emphasizing Agriculture, Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

floodwater retarding structures and diversion will provide intermittent employment for local residents.

During the construction stage of the proposed project, additional requirements for construction materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 43 man-years of employment, which will further strengthen the economy during this phase. 1/

Additional intangible benefits will accrue to the project through the opportunity to shift public funds from the repair of damages to public roads and utilities to investment in schools and other public facilities that improve the quality of living. Likewise private funds now going to repair flood damage can be shifted to raising the standard of living of the residents in the affected area. The elimination or reduction of flooding will allow owners of residential and business units to upgrade their properties, thereby, creating a more pleasant environment in which to live and work. Significant intangible public health benefits will accrue in the city of Van Horn, including reduced hazards of loss of life and injury, elimination of health hazards associated with damage to water supply and waste disposal systems, improved vector control, and the prevention of other factors accompanying floods which tend to disrupt the maintenance of public health.

Other

The installation of two floodwater retarding structures and 55,000 feet of floodwater diversion will require the commitment of a total of 1,781 acres of rangeland to project purposes. A total of 528 acres of this rangeland required for dams, emergency spillways, sediment pools, and auxiliary borrow areas will be retired from agricultural production as its primary use.

There are no areas such as feed lots in the watershed with large concentrations of livestock. Livestock within the drainage areas of the floodwater retarding structures are on rangeland. Due to the low carrying capacity of approximately one animal unit per 100 acres of rangeland, appreciable contamination from livestock to water in the sediment pools is not anticipated.

The sediment pools of the floodwater retarding structures will provide an intermittent water supply for livestock and wildlife.

The construction and functioning of the floodwater retarding structures and floodwater diversion will not affect mineral resources. Project planners, which included Soil Conservation Service geologists and

1/ Estimated from an adaptation of An Input-Output Analysis of the Texas Economy Emphasizing Agriculture, Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

engineers, were aware of the locations of the Hazel Mine and talc deposits during development of the work plan. Floodwater Retarding Structure No. 1 is located about 2.5 miles downstream from the Hazel Mine, and Floodwater Retarding Structure No. 2 is approximately 5.0 miles downstream from the talc deposits. There will be no hazard to these resources from water temporarily detained in the structures' retarding pools. During and after construction of the structures, present ingress and egress conditions to the mine and talc deposits will not be significantly affected. There will be no public roads affected in the vicinity of the site for Floodwater Retarding Structure No. 1. However, a private road maintained by the county, which is an access route to the talc deposits, will require modification or rerouting in the vicinity of the Floodwater Retarding Structure No. 2 site to remain in a passable condition. This will be accomplished by the Culberson County Commissioners Court prior to the initiation of construction operations or in a timely manner that normal traffic will not be impeded.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, flood plain erosion, and indirect damages (table 5) within the watershed will be reduced from $161,060 to $12,100 by the proposed project. This is a reduction of 92.5 percent.

Benefits to landowners and operators from the planned land treatment measures were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

Reduction in monetary flood damages vary with respect to locations within the watershed. The following tabulations show the general locations of the damage reduction benefits attributed to the combined program of land treatment and structural measures.

Evaluation Reach (figure 1)	Location	Average Annual Damage: Without Project (dollars)	With Project (dollars)	Reduction 1/ (percent)
1	Urban Area - City of Van Horn	4,540	0	100.0
2	Agricultural Area	156,520	12,100	92.3
TOTAL		161,060	12,100	92.5

1/ Reduction based on consideration of floods up to and including the 100-year frequency event.

Direct Monetary Floodwater Damage

Evaluation Reach (figure 1)	Recurrence Interval: 2-Year Without Project (dollars)	2-Year With Project (dollars)	5-Year Without Project (dollars)	5-Year With Project (dollars)	25-Year Without Project (dollars)	25-Year With Project (dollars)	100-Year Without Project (dollars)	100-Year With Proj (doll
1	0	0	0	0	0	0	75,470	
2	27,500	400	148,960	2,950	306,980	9,150	449,100	21,
TOTAL	27,500	400	148,960	2,950	306,980	9,150	524,570	21,

It is estimated that the project will produce local secondary benefits averaging $33,230 annually. 1/ Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation and project administration cost, plus operation and maintenance) is $70,730. These measures are expected to produce average annual benefits, excluding secondary benefits, of $140,720 resulting in a benefit-cost ratio of 2.0:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($173,950) to the average annual cost of structural measures ($70,730) is 2.5:1.0 (table 6).

PROJECT INSTALLATION

Planned land treatment measures will be established during a five-year installation period by private landowners and operators under the leadership and cooperation of the High Point Soil and Water Conservation District. Soil Conservation Service technical assistance to the High Point Soil and Water Conservation District is provided by Public Law 46 and an existing memorandum of understanding between the district and the United States Department of Agriculture. Soil Conservation Service assistance is available at the request of the district and local land users.

1/ Estimated from an adaptation of Upper Rio Grande Valley-Texas Interindustry Study, Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, April 1972.

The goal is to increase the level of applied land treatment to 88 percent of the total needs during the installation period. In reaching this goal, it is expected that accomplishments in applying the additional land treatment will progress as indicated in the following tabulation:

Land Use	Fiscal Year					Total
	1st	2nd	3rd	4th	5th	
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Cropland	1,110	1,110	1,120	1,130	1,130	5,600
Rangeland	4,150	4,150	4,150	4,150	4,200	20,800
Pastureland	-	10	10	-	-	20
TOTAL	5,260	5,270	5,280	5,280	5,330	26,420

Special emphasis will be placed on establishing a higher degree of land treatment in the drainage areas of the floodwater retarding structures and floodwater diversion. Landowners and operators will be provided technical assistance in applying and maintaining measures that will benefit wildlife.

The Extension Service will assist with the educational phase of the program by providing information to landowners and operators in the watershed.

The Culberson County Commissioners Court has rights of eminent domain under applicable state law and have the financial resources to fulfill its responsibilities.

The Soil Conservation Service, in compliance with a request from the sponsors, will be the contracting agency and will provide the necessary administrative and clerical personnel; facilities, supplies, and equipment to advertise, award, and administer contracts. The Culberson County Commissioners Court will represent the sponsoring local organization in coordination with the Soil Conservation Service on matters concerning construction.

The Culberson County Commissioners Court will have the following responsibilities pertaining to the two planned floodwater retarding structures and the floodwater diversion:

1. Obtain necessary land rights for all works of improvement;

2. Provide for the change in location or modification of private roads, and other privately owned improvements necessary for installation of the floodwater retarding structures and the floodwater diversion;

3. Provide for the necessary improvements to low water crossings on public and private roads to make them passable during prolonged release flows from the floodwater retarding structures and along the floodwater diversion or provide equal alternate routes for use during periods of inundation;

4. Determine and certify legal adequacy of easements and permits for construction of structural measures; and

5. Obtain a court order providing that the county roads and private roads maintained by the county affected by Floodwater Retarding Structure No. 2 and the floodwater diversion be closed and rerouted, raised or modified at no expense to the federal government.

Technical assistance will be provided by the Soil Conservation Service in preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install planned structural measures.

The structural measures will be constructed during the second, third, and fourth years of a five-year project installation period in the general sequence as follows:

Second Year - Floodwater Retarding Structure No. 2
Third Year - Floodwater Retarding Structure No. 1
Fourth Year - Floodwater Diversion

In order for construction to proceed according to schedule, all land rights for floodwater retarding structures and the floodwater diversion are scheduled by the Culberson County Commissioners Court to be secured by the end of the periods as shown in the following tabulation. The schedule will begin when the work plan is approved for operations.

Time Period	Works of Improvement
First six months	Floodwater Retarding Structure No. 2
Second six months	Floodwater Retarding Structure No. 1
Third six months	Floodwater Diversion

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out works of improvement described in this work plan will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

The cost of applying land treatment measures will be the responsibility of landowners and operators. Financial assistance is available to land

users through the Rural Environmental Conservation Program administered by the Agricultural Stabilization and Conservation Service on a cost-share basis for the installation of needed land treatment measures. Funds provided under the going program (Public Law 46) will be used for technical assistance in planning and applying soil and water conservation measures.

Funds for the local share of the cost of this project relative to structural measures will be provided by Culberson County. The sponsors have the financial ability to make adequate arrangements to carry out their responsibilities in all phases of project installation and in operation and maintenance. The Commissioners Court of Culberson County will set aside revenue funds to finance the local share of installation cost of the two planned floodwater retarding structures and approximately 55,000 feet of floodwater diversion.

It is anticipated that approximately 80 percent of the easements for structural measures will be donated. Out-of-pocket costs for land rights, legal expenses, and project administration are estimated to be about $18,000.

Structural measures will be constructed during the second, third, and fourth years of a five-year project installation period pursuant to the following conditions having been met by the sponsoring local organization:

1. Requirements for land treatment in drainage areas of floodwater retarding structures have been satisfied.

2. All land rights have been obtained for all structural measures, or a written statement is furnished by the Culberson County Commissioners Court that its right of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for purchasing land easements and rights-of-way.

3. Provisions have been made for improving low water crossings on public roads, or court orders, or necessary permits obtained granting permission to temporarily inundate the crossings, provided equal alternate routes are available for use by all people concerned, during periods when these crossings are impassable due to prolonged flow from principal spillways of floodwater retarding structures. If equal alternate routes are not available, provision will be made, at no cost to the federal government, to make the crossings passable during prolonged periods of release flow from the structures.

4. A court order has been issued by the Culberson County Commissioners Court showing that the county roads affected by

Floodwater Retarding Structure No. 2 and the floodwater diversion will be closed and rerouted, raised or modified at no expense to the federal government.

5. Operation and maintenance agreements have been executed.

6. Project agreements have been executed.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent upon the appropriation of funds for this purpose.

Various features of cooperation between the cooperating parties have been covered in appropriate memorandums of understanding and working agreements.

The Soil and Water Conservation Loan Program sponsored by the Farmers Home Administration is available to eligible farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies to outline available services and eligibility requirements. Present FmHA clients will be encouraged to cooperate in the program.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Data

Planned land treatment measures will be operated and maintained by landowners and operators of farms and ranches on which measures are applied. This will be done under agreement with the High Point Soil and Water Conservation District. Representatives of the District will periodically survey the status of land treatment measures and encourage land users to apply necessary maintenance.

Structural Measures

Upon acceptance of the two floodwater retarding structures and the floodwater diversion, the Culberson County Commissioners Court will be totally responsible for all maintenance. The court will perform promptly, without cost to the Service, all maintenance of the structural measures as determined to be needed by either the sponsors or the Service.

The Soil Conservation Service, through the High Point Soil and Water Conservation District, will participate in operations and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

The estimated annual operation and maintenance cost for floodwater retarding structures and the floodwater diversion is $3,000. Monies for operation and maintenance will be supplied from the general fund of Culberson County. This fund is supported by revenue from existing

taxes. Each year the Culberson County Commissioners Court will budget sufficient funds for operation and maintenance.

The Culberson County Commisssioners Court will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement for each floodwater retarding structure and the floodwater diversion, in accordance with provisions of the Texas Watersheds Operations and Maintenance Handbook. The operation and maintenance agreement for each structure will be prepared and executed prior to the signing of a project agreement for the construction of any of the structures. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution. It will also include specific provisions for retention and disposal of property acquired or improved with Public Law-566 financial assistance.

Floodwater retarding structures and the floodwater diversion will be inspected at least annually and after each heavy rain by representatives of the Culberson County Commissioners Court and the High Point Soil and Water Conservation District. A Soil Conservation Service representative will participate in these inspections for a period of at least three years following construction. The Soil Conservation Service will participate in inspections as often as it elects to do so after the third year. The location and type of needed maintenance will be determined as a result of the inspections. Items of inspection will include, but will not be limited to, conditions of principal spillways and their appurtenances, emergency spillways, earth fills, degradation, aggradation, slope erosion, obstruction of flow caused by debris and/or sediment deposited in the diversion channel, growth of brush and woody plants, and the condition of major drains into the floodwater diversion. The need for frequent removal of sediment deposits in the floodwater diversion channel at the entrance of major natural drains is anticipated.

A written report will be made of each inspection. A copy of each report will be provided by the Culberson County Commissioners Court to the designated Service representative within ten days of the date on which the inspection was made.

Provisions will be made for unrestricted access by representatives of sponsoring local organization and the Soil Conservation Service to inspect all structural measures and their appurtenances at any time and for sponsoring local organization to operate and maintain them. Easements insuring this unrestricted ingress and egress will be furnished by the Culberson County Commissioners Court.

Sponsors will control the handling, storage, and application of herbicides and pesticides that may be necessary for operation of the structural works of improvement. Approved reagents and compounds will be used. Their application will be compatible with current laws regulating their use. In addition to sound and prudent judgment, ordinances and

standards concerned with the disposal or storage of unused chemicals, empty containers, contaminated equipment, etc., will be observed and applied.

The Culberson County Commissioners Court will maintain a record of all maintenance inspections made and maintenance performed and have it available for inspection by Soil Conservation Service personnel.

The necessary maintenance work will be accomplished either by contract, force account, or equipment owned by sponsoring local organization.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Three-Mile and Sulfur Draw Watershed, Texas

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ Public Law 566 Funds Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT					
Land Areas 2/					
Cropland	Acre	5,600	-	152,430	152,430
Pastureland	Acre	20	-	950	950
Rangeland	Acre	20,800	-	17,920	17,920
Technical Assistance			-	19,000	19,000
TOTAL LAND TREATMENT			-	190,300	190,300
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Floodwater Retarding Structures	No.	2	618,020	-	618,020
Floodwater Diversion	Feet	55,000	267,520	-	267,520
Subtotal - Construction			885,540	-	885,540
Engineering Services					
Soil Conservation Service					
Floodwater Retarding Structures	No.	2	30,900	-	30,900
Floodwater Diversion	Feet	55,000	13,380	-	13,380
Subtotal - Engineering Services			44,280	-	44,280
Project Administration					
Soil Conservation Service					
Construction Inspection			53,130	1,000	54,130
Other			75,390	1,000	76,390
Subtotal - Project Administration			128,520	2,000	130,520
Other Costs					
Land Rights			-	42,450	42,450
Subtotal - Other Costs			-	42,450	42,450
TOTAL STRUCTURAL MEASURES			1,058,340	44,450	1,102,790
TOTAL PROJECT			1,058,340	234,750	1,293,090

1/ Price Base : 1975

2/ Includes only areas estimated to be adequately treated during project installation period. Treatment will be applied throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

Three-Mile and Sulfur Draw Watershed, Texas

Measures	Unit	Number Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	4,500	4,500
Crop Residue Management	Acre	2,410	1,200
Irrigation Land Leveling	Acre	1,000	40,000
Irrigation System, Surface and Subsurface	No.	2	4,000
Irrigation Water Management	Acre	1,040	1,560
Diversion	Feet	6,200	1,240
Grassed Waterway	Acre	20	1,200
Deferred Grazing	Acre	55,230	11,050
Proper Grazing Use	Acre	62,110	6,210
Pasture and Hayland Planting	Acre	100	2,500
Pasture and Hayland Management	Acre	100	1,000
Wildlife Upland Habitat Management	Acre	8,800	4,400
TOTAL LAND TREATMENT			78,860

1/ Price Base: 1975

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Three-Mile and Sulfur Draw Watershed, Texas
(Dollars) 1/

	Installation Costs P. L. 566 Funds			Installation Costs Other Funds		Total Installation Cost
	Construction	Engineering	Total P. L. 566	Land Rights	Total Other	
Floodwater Retarding Structures						
1	260,670	13,030	273,700	2,160	2,160	275,860
2	357,350	17,870	375,220	4,750	4,750	379,970
Subtotal	618,020	30,900	648,920	6,910	6,910	655,830
Floodwater Diversion	267,520	13,380	280,900	35,540	35,540	316,440
Subtotal	267,520	13,380	280,900	35,540	35,540	316,440
Subtotal -	885,540	44,280	929,820	42,450	42,450	972,270
Project Administration	-	-	128,520	-	2,000	130,520
GRAND TOTAL	885,540	44,280	1,058,340	42,450 2/	44,450	1,102,790

1/ Price Base: 1975

2/ Includes $3,500 for legal fees and surveying cost and $5,190 for change in location or modification of other fixed improvements and utilities.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Three-Mile and Sulfur Draw Watershed, Texas

Item	Unit	Structure Number 1	Structure Number 2	Total
Class of Structure		B	C	xxx
Drainage Area	Sq.Mi.	9.57	26.51	36.08
Curve No. (1-day)(AMC II)		82	80	xxx
T_c	Hrs.	1.40	1.85	xxx
Elevation Top of Dam	Ft.	4,565.9	4,225.6	xxx
Elevation Crest Emergency Spillway	Ft.	4,556.4	4,210.0	xxx
Elevation Crest Principal Spillway	Ft.	4,535.5	4,189.5	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	4,532.7	4,184.4	xxx
Maximum Height of Dam	Ft.	79	57	xxx
Volume of Fill	Cu.Yd.	194,410	350,340	544,750
Total Capacity	Ac.Ft.	1,001	2,644	3,645
Sediment Pool (Lowest Ungated Outlet) 1/	Ac.Ft.	200	200 2/	400
Sediment Submerged	Ac.Ft.	250	353	603
Sediment in Detention Pool-Aerated	Ac.Ft.	46	71	117
Retarding Pool	Ac.Ft.	705	2,220	2,925
Surface Area				
Sediment Pool (Lowest Ungated Outlet)	Acres	17	31	48
Sediment Pool-Principal Spillway Crest	Acres	20	48	68
Retarding Pool	Acres	53	186	239
Principal Spillway				
Rainfall Volume (areal)(1-day)	In.	4.70	4.53	xxx
Rainfall Volume (areal)(10-day)	In.	7.80	7.66	xxx
Runoff Volume (10-day)	In.	2.48	1.81	xxx
Capacity (Maximum)	cfs	140	180	xxx
Frequency Operation-Emergency Spillway	% chance	1	1	xxx
Size of Conduit	In.	30	36	xxx
Emergency Spillway				
Rainfall Volume (ESH)(areal)	In.	7.00	8.05	xxx
Runoff Volume (ESH)	In.	4.91	5.67	xxx
Type		Rock	Rock	xxx
Bottom Width	Ft.	250	450	xxx
Velocity of Flow (V_e)	Ft./Sec.	19.0	25.0	xxx
Slope of Exit Channel	Ft./Ft.	0.034	0.050	xxx
Maximum Water Surface Elevation	Ft.	4,561.5	4,216.7	xxx
Freeboard				
Rainfall Volume (FH)(areal)	In.	13.50	21.17	xxx
Runoff Volume (FH)	In.	11.18	18.44	xxx
Maximum Water Surface Elevation	Ft.	4,565.9	4,225.6	xxx
Capacity Equivalents				
Sediment Volume	In.	0.58	0.30	xxx
Retarding Volume	In.	1.38	1.57	xxx

1/ Volume included in submerged sediment.

2/ Includes volume created by anticipated excavation of earth materials for dam.

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TABLE 3A - STRUCTURE DATA - FLOODWATER DIVERSION

Three-Mile and Sulfur Draw Watershed, Texas

Station	Drainage Area Sq.Mi. 1/	Capacity cfs 2/ Required	Capacity cfs 2/ Design	Water Surface Elev. 3/	Hydraulic Gradient (ft./ft.) 4/	Diversion Dimensions 5/ Bottom (ft.)	Depth 6/ (ft.)	Side Slopes	"n" Value Aged	"n" Value As Built	Velocities (ft./sec.) Aged 2/	Velocities (ft./sec.) As Built 7/	Excavation (1000 cu.yds.)	Type of Improvement 8/
0+00	69.61	3,160	3,160	3727.8	.002	60	8.6	4:1	.035	.025	5.5	4.0	-	FD
245+50	58.94	2,950	2,950	3777.1	.002	60	8.4	4:1	.035	.025	5.4	3.8	257	FD
416+20	39.21	2,195	2,195	3810.3	.002	60	7.4	4:1	.035	.025	4.9	3.7	146	FD
547+90	End of Diversion			3835.2	.002	60	5.6	4:1	.035	.025	3.9	3.5	72	FD

1/ Uncontrolled drainage area
2/ 100-year frequency
3/ Based on aged "n" values for 100-year frequency design
4/ Computed from water surface profile data
5/ See Figure 4 - Typical Cross Section
6/ Includes 2.0 feet freeboard
7/ 10-year frequency
8/ Floodwater diversion

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TABLE 4 - ANNUAL COST

Three-Mile and Sulfur Draw Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures 1 and 2 and Floodwater Diversion	59,710	3,000	62,710
Project Administration	8,020		8,020
GRAND TOTAL	67,730	3,000	70,730

1/ Price Base: 1975

2/ 100-years at 6.125 percent interest

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Three-Mile and Sulfur Draw Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	52,260	1,730	50,530
Other Agricultural	22,000	730	21,270
Nonagricultural			
Road and Bridge	2,860	140	2,720
Urban 2/			
Residential Property	3,550	0	3,550
City Streets and Cemetery	230	0	230
Subtotal	80,900	2,600	78,300
Sediment			
Deposition	17,650	1,740	15,910
Erosion			
Flood Plain Scour	47,520	6,660	40,860
Indirect	14,990	1,100	13,890
TOTAL	161,060	12,100	148,960

1/ Price Base: Agricultural damages current normalized prices, October 1974 Other damages 1975 prices.

2/ Evaluation of damages resulting from floods up to and including a 100-year frequency event. Floods larger than the 100-year frequency event will cause damage after project installation.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Three-Mile and Sulfur Draw Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/			Average Annual Cost 2/	Benefit - Cost Ratio
	Damage Reduction	Secondary	Total		
Floodwater Retarding Structures Numbers 1 and 2 and Floodwater Diversion	140,720	33,230	173,950	62,710	2.8:1.0
Project Administration				8,020	
GRAND TOTAL	140,720	33,230	173,950	70,730	2.5:1.0

1/ Price Base: Agricultural benefits current-normalized prices, October 1974. Other benefits-1975 prices.

2/ Installation, 1975 prices, amortized at 6.125 percent for 100 years. Operation and Maintenance - 1975 cost.

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $8,240 annually.

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INVESTIGATIONS AND ANALYSIS

Land Use and Treatment

Land treatment data for the watershed was developed by the High Point Soil and Water Conservation District with technical assistance by personnel from the Soil Conservation Service field office at Van Horn, Texas. Needed conservation practices and measures were compiled from existing conservation plans within the watershed and expanded to represent the conservation needs of the entire watershed. The quantity of each land treatment practice, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. The estimated number of acres, by land use, to be treated during the installation period are shown on Table 1. Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from the application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of flood damage reduction desired by local people.

Hydraulics and Hydrology

Basic meterologic and hydrologic data were obtained from the Weather Bureau, Environmental Science Services Administration, U.S. Department of Commerce. Rainfall tabulations were made of Weather Bureau station records at Van Horn and in the vicinity of the watershed, and local records in and near the watershed. Orographic influence on rainfall was considered throughout the watershed.

Rainfall frequency data for the watershed were obtained from Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas for the United States."

Present hydrologic conditions were determined from a 76 percent sampling of soil and cover conditions. The with-project hydrologic conditions were determined by considering the effects of treatment that can be expected during the installation period.

The area subject to damage from flooding was determined by studies of aerial photographs, U.S. Geological Survey quandrangle sheets, and field interviews with local residents. Information concerning past floods and flooding was obtained from local residents. These investigations were used to determine the area that would be flooded by selected frequency floods under each of the following conditions:

1. Without project conditions, using the present soil cover complex number.

2. With project conditions of the watershed, using various systems of structural measures with the future soil cover complex number.

Reservoir operation studies were completed to determine the feasibility of including recreational water storage in Floodwater Retarding Structure No. 2. Results of the studies indicated that adequate recreational water storage could be obtained in the structure.

Engineering

Two floodwater retarding structures and approximately 55,000 feet of floodwater diversion were selected for inclusion in the final work plan. Structure locations are shown on Figure 5. Table 3 provides specific site information.

Intensive investigations and field surveys were made on the upper Sulfur Draw site and the Three-Mile Draw site. Multiple routings for principal spillway sizing to determine floodwater retarding storage were made.

Also multiple routings of freeboard hydrographs were made to determine spillway proportions and height of dam which would result in the most economical and feasible design of structures.

Sediment and floodwater storage, structure classification, and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 (Rev.) and Texas State Manual Supplement 2441. The average antecedent moisture condition existing in the area was used to determine the floodwater diversion design discharges. Hydraulic parameters of the diversion were developed by use of the Project Formulation Hydraulics Program. The top elevation was established by adding 2.0 feet to the 100-year water surface elevation. Computations were made for an "n" value of 0.025 for "as built" conditions and 0.035 for "aged" conditions.

An investigation of materials through which the floodwater diversion will be excavated was made. These materials consist of clay and clayey gravel along most of its length. Along short reaches where the diversion crosses mountain stream outwashes, the materials are mostly silty sand and gravel. The clay and clayey gravels have a plasticity index of about 10. The allowable velocity for the 100-year clear water discharge in an unprotected earth channel of these materials would be 7.5 feet per second. The mountain stream outwash consists mainly of coarse sand and gravel.

Annual erosion rates and sediment yield to the diversion were computed using Soil Conservation Service procedures. Bedload transport studies indicated that three of the six-acre feet that are delivered annually to the diversion would be deposited in the system. Maintenance cost includes provisions for the removal of these deposits. The diversion

outlets on a flat outwash area that is plated with gravel and cobbles. Cost of maintaining an open outlet were included in the maintenance cost estimates.

When structural measures for flood prevention had been determined, a table was developed to show the total cost of each structure (table 2).

A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of structural measures (table 4).

Geology

Preliminary geologic investigations were made at each of the floodwater retarding structure sites and along the centerline of the floodwater diversion. These investigations were carried out to obtain information on the nature, quantity, and location of embankment and foundation materials, type and location of materials in emergency spillway excavation, emergency spillway and embankment foundation stability, and other possible problems that could be encountered during construction. Included in the investigations were observations of exposed geologic strata, channel banks, alluvium, and valley slopes. Portable seismic equipment was utilized and soil samples were submitted to the Materials Testing Section at Fort Worth. Geologic maps, reports, and other literature concerned with the watershed and vicinity were reviewed and studied. The findings of the investigations were used in making cost estimates for the structures, to assure that the designs and sites selected are feasible for construction, to determine suitability of soils materials for construction needs, and their ability to withstand anticipated erosive forces after installation.

Detailed investigations, including exploration with core drilling equipment will be made at all sites prior to final design. Soil samples will be submitted for laboratory analysis to determine suitability and methods of handling foundation and embankment materials.

Sedimentation

Sediment Storage

Determination of 100-year sediment storage requirements for the floodwater retarding structures was made according to the following procedure.

> Detailed studies were made of soils, slopes, and cover on 100 percent of the drainage area contolled by the floodwater retarding structures. Average annual sheet erosion rates for present and anticipated future conditions were computed using the soil loss equation by Musgrave. The Musgrave equation was the standard by which soil losses were determined at the time the project was being planned. Presently, the Universal Soil Loss equation is in standard

use by the Soil Conservation Service. The use of the Universal equation can be expected to produce similar results when compared to the Musgrave equation.

Computations of gully and streambank erosion were based on estimated lateral bank erosion rates, bank heights, and channel lengths affected by erosion.

Sediment delivery ratios and trap efficiency adjustments were applied to computed average annual erosion to arrive at estimates of sediment volumes to be deposited in reservoirs. Allowances were made for differences in unit weights between aerated and temporarily submerged-aerated sediment. The weights used were 90 pounds and 75 pounds per cubic foot respectively.

Allocation of sediment to the pools of the floodwater retarding structures was based on sediment texture and reservoir topography. The allocation for Structure No. 1 was 84 percent to the sediment pool and 16 percent to the detention pool. For Structure No. 2 the allocation was 83 percent to the sediment pool and 17 percent to the detention pool.

Floodwater Diversion Sedimentation

Erosion rates were computed as outlined under "Sediment Storage." Sediment delivery ratios and trap efficiency adjustments were used to determine the net annual weight of sediment expected to accumulate in the floodwater diversion system. The net annual sediment accumulation was converted from weight to volume to facilitate computing the cost of annual maintenance.

Flood Plain Land Damages

Investigations were made to determine the nature and extent of physical damage to flood plain lands. The area mapping method was used on the irrigated cropland. Factors such as depth and texture of sediment deposits, soil condition, and depth and width of scoured areas were observed and delineated on aerial photographs.

A damage table was developed to show percent loss of productive capacity by texture and depth increment for sediment and by depth and width for scour. Due consideration was given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages. Adjustments for recoverability of productive capacity with the project installed were then applied.

The estimated average annual sediment yield from each source (sheet erosion, gully erosion, and streambank erosion) was based on detailed sediment source studies. Sediment yields to the irrigated cropland area were computed for without project conditions, with planned land treatment measures applied, and with the combined program of land treatment

and structural measures installed. The reductions in sediment yields were adjusted to reflect the relative importance of each sediment source as a contributor of damage.

The reduction of scour damage on irrigated cropland due to installation of the project was based on reduction of depth and area inundated by floodwater. This reduction is 100 percent from runoff caused by the one percent storm event on the area above the floodwater diversion.

Reduction of scour and sediment damages on rangeland were not calculated because damages were found not to be monetarily significant.

Economics

Basic methods used in the economic investigations and analyses are outlined in the "Economics Guide for Watershed Protection and Flood Prevention," U.S. Department of Agriculture, Soil Conservation Service, March 1964.

Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into two evaluation reaches (figure 1).

Determination of Agricultural Damages

Agricultural damage calculations were based on information obtained in interviews with owners and operators of approximately 50 percent of the acreage of the flood plain. Schedules covered flooding and flood damage; past, present, and intended future use; and yield data. Verification of information gained by interviews in the field was obtained from local agricultural technicians.

The overland flow method of analysis was used in determining crop and pasture damage. No adjustment was made for recurrent flooding as flooding during a single year over the same area is unlikely because of the alternative paths the flow can take.

Other agricultural damages to irrigation facilities, fences, farm roads, and the cost of releveling irrigated fields were estimated from information collected in the field and correlated with area and depth of flooding.

Monetary damages to the flood plain from scour and infertile sediment deposition were based on the loss in value of production. Scour damage reduction was related to the area of flooding. Reduction in monetary damages from sediment deposition was based on the effectiveness of land treatment measures, trap efficiency of planned structural measures, and the average annual area flooded under each progressive phase of the project.

Determination of Nonagricultural Damages

Using the overland flow method of analysis, it was determined that the average depth of urban flooding would be approximately 0.4 of a foot above natural ground for a flood expected on an average of once in 100 years. It was determined that the existing floodwater diversion above Van Horn offers adequate protection from floods up to and including a flood which could be expected on an average of once in 25 years. An evaluation was made of all properties located within the urban area of Van Horn that would be subject to damage from a flood which could be expected to occur on an average of once in 100 years.

An analysis was made of existing data pertaining to the economic development of the Van Horn area. In addition, data developed by the Office of Business Economics (OBE), U.S. Department of Commerce, for Area 10138, which includes the city of Van Horn, was analyzed to determine the factors which have contributed to the overall growth of the area. Bank deposits were also considered. A comparison of pertinent historic data relative to economic activities in Van Horn and in the total OBE area indicates that population, per capita income, and the resulting total personal income are increasing at a slightly faster rate than projected for the OBE area.

The urban flood plain of Van Horn is subject to infrequent flooding due to the existing diversion. The property in the flood plain is composed primarily of average to above average residential units. Property subject to flooding will continue to increase in value because of progressively higher per capita income. For this reason, it is believed that projections of per capita income best reflects the value of properties that would be subject to flood damage even in the absence of a project. Therefore, damage to the existing development was increased by 97.9 percent to reflect the gradual accrual of these values discounted to present worth.

Expenses associated with dislocation of residents will be high. It is estimated that indirect damages to urban property would approximate 20 percent of the direct damage.

Estimates of damages to roads, highways, and bridges in the flood plain were obtained from county officials, state highway officials, and supplemented by information from local residents.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over the period of project life. No production in sediment pools was considered and the land covered by detention pools was assumed to be

rangeland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification.

Indirect Damage Reduction Benefits

Expenses associated with disruption of agricultural operations, interruption of travel, rerouting of school buses and mail routes, business losses, and similar losses will be incurred. Indirect damages were estimated to be 10 percent of crop and pasture, other agricultural, sediment, and erosion damages and 20 percent of urban property damages.

Secondary Benefits

Secondary benefits were estimated by adaptation of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in "Upper Rio Grande Valley - Texas Interindustry Study" which was developed as part of the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, April 1972.

Increased employment resulting from the proposed project was estimated by the use of multipliers as calculated in "An Input-Output Analysis of the Texas Economy Emphasizing Agriculture," by Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

Archeology

Archeological surveys and investigations were conducted in the watershed by the Archaeology Research Project, Southern Methodist University, under contract with the Service. The initial surveys located and evaluated archeological sites within areas affected by the construction of the planned floodwater retarding structures and floodwater diversion. Upon conclusion of these initial surveys, it was recommended that additional field investigations and studies be accomplished, such as mapping, artifact collecting, and testing, to determine if major excavations would be necessary before the beginning of construction. The additional field investigations have been completed, and a recommendation submitted that further work is unwarranted for the affected archeological sites.

The following is extracted from the report resulting from the initial survey, "Prehistoric Archaeology in the Three-Mile and Sulphur Draw Watershed" by Dr. S. Alan Skinner and Mr. C. Britt Bousman, Archaeology Research Program, Department of Anthropology, Southern Methodist University.

> "Culberson County has attracted little attention from professional archaeologists since 1938 when A. T. Jackson documented pictographs and petroglyphs in the county. The lack of interest can be attributed to the distance, 120 miles, between Van Horn, the

county seat, and El Paso, the closest metropolitan center, to the lack of massive development in the county and to the absence of well-known, spectacular archaeological resources.

Recent studies in the county have been done by amateur archaeologists. In 1970 the Texas Archeological Society held their Summer Field School in Archeology at Guadalupe Peak National Park near the northern boundary of the county (Shafer 1970). The final report on this work is being completed. During the school, 150 archaeological sites were recorded; these included rock shelters, rock art sites with pictographs and petroglyphs, ring middens, hearth sites, mortar hole sites plus important nineteenth century historic sites.

Beginning in 1960, John A. Hedrick of El Paso studied the archaeogical resources in the vicinity of Plateau, 16 miles east of Van Horn (Hedrick 1968, 1972). This area is bisected by Plateau Draw which drains northward into Wild Horse Draw. Permanent water sources are not present on the surface of the ground but modern irrigation techniques show that the soil has agricultural potential. Hedrick reports finding three different types of sites in the area. Large open campsites, the first type of site, cover an area 30 to 50 feet in diameter. Stone-lined hearths are the most common structural feature, although occasionally fire-blackened areas are all that occur. Artifacts are numerous and include lithic debris, cores, scrapers, arrow points, pottery, manos and metates. Small, isolated campsites occur scattered in the sand dunes between the larger sites. Hearths are absent at the small sites and a small amount of lithic debris is usually found at these sites. The third site type, quarry chipping/stations, is located in low hills northeast and southeast of Plateau. Flint from these sites has a distinctive coloring which has been traced to sites near Monahans (Jay C. Blaine, personal communication). The major occupation at the Plateau sites was during the period A.D. 900-1300; however, based on the projectile point styles that have been found in vertically stratified deposits in central and south Texas there appears to be an earlier Late Archaic occupation probably between 2000 B.C. and A.D. 900.

During 1973 the Diamondhead Corporation sponsored archaeological investigations at MILEHIGH, a planned community development to be located north of Sierra Blanca. An extensive survey of the more than 100,000 acres has resulted in the recording of more than 120 prehistoric sites. The heaviest occupation is attributed to the period between A.D. 900-1300, although evidence of earlier Archaic and possibly Paleo-Indian occupation is present. Sites include rock shelters, ring middens, hearth sites, quarries, pictographs and petroglyphs, and mortar hole concentrations (Glander, Sanders and Skinner 1973; Skinner and Bearden 1973). It is hypothesized

that prehistoric occupation of MILEHIGH was by small groups (extended families) of people who came to the area to gather and harvest specific food resources that were available during the "wet" season in the early fall. It is suggested that this area was a part of the settlement system of the Jornada Culture people who lived permanently in villages located west of Sierra Blanca. Reconstruction of the settlement system will require additional site survey and excavation in the MILEHIGH area and to the west of Sierra Blanca.

Archaeological studies lend support to the hypothesis that prehistoric occupation in the Sierra Blanca-Van Horn area was of a seasonal and/or activity specific nature. At the Soil Conservation Service dams to be located at Diablo Arroyo and Alamo Arroyo in southwest Hudspeth County Rex Gerald of the El Paso Centennial Museum recorded nine prehistoric sites and excavated three of these. It is postulated that each site was occupied for a short period, a few days, by a small number of people, a band of extended family. Gerald suggests that the sites were visited seasonally for gathering by people who lived in permanent villages located closer to the Rio Grande or around some of the lake basins to the north (Gerald 1959). A similar settlement pattern is postulated from a survey of the Sanderson Canyon Watershed that was done in conjunction with planned Soil Conservation Service floodwater retarding structures (Shafer 1971). Due to the scope of these studies it has been impossible to formulate a model of the overall settlement system. In order to evaluate the importance of each individual site it is necessary to have a model which explains the archaeological evidence that is present in the study area. Without this information it is difficult to evaluate a site's importance to local, regional and countrywide resources.

To the west, north and east of Van Horn there is evidence of permanent villages during the period A.D. 900-1350. In the El Paso area, the Jornada Branch (Lehmer 1948) is well documented. Particular attention has been paid to excavation of El Paso phase pueblos and the study of artifacts from these sites. In southeastern New Mexico the Lea County Archaeological Society has excavated the Merchant site and the Laguna Plata site. Both sites include horse structures in villages. Permanent structures were also located at the Andrews Lake Locality near Midland, Texas (Collins 1968, 1969). Although each of these locations is more than one hundred miles from Van Horn, it is possible that similar settlements are located in the intervening area or that the area of exploitation included this large area. An alternative explanation is that a restricted base wanderer community pattern (Beardsley and others 1956) is applicable in the west Texas area as it has been suggested in the Robert Lee Reservoir area to the northeast (Skinner 1971:265)."

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department and the Soil Conservation Service, completed a reconnaissance study of Three-Mile and Sulfur Draw Watershed. This report was valuable in work plan development pertaining to fish and wildlife. The major portion of this report is contained in the Effects of Works of Improvement section of this work plan. Data from field office files and information gathered from local people with knowledge of fish and wildlife was used in assessing the impact of the project on fish and wildlife resources.

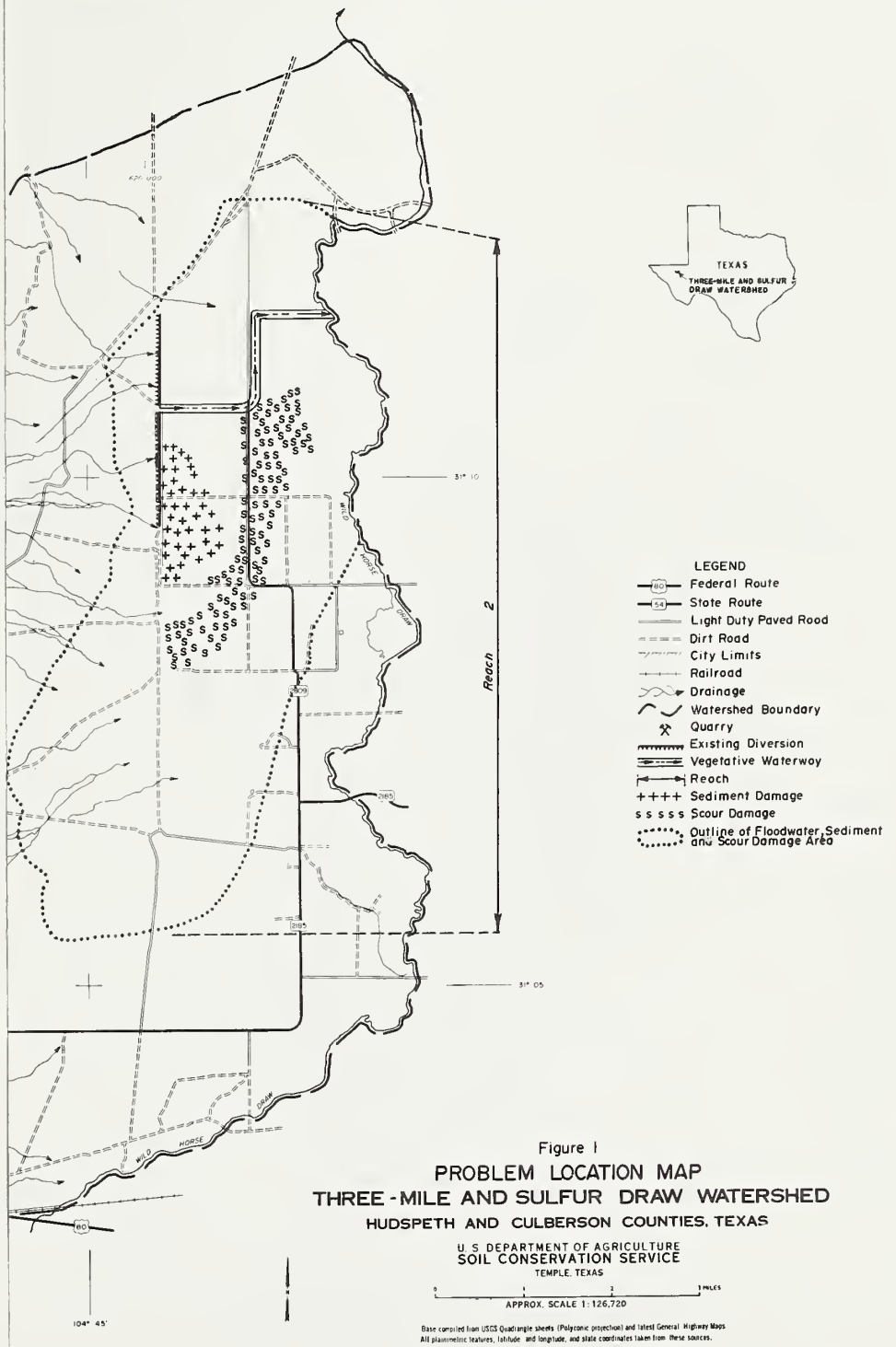


Figure 1

PROBLEM LOCATION MAP
THREE-MILE AND SULFUR DRAW WATERSHED
HUDSPETH AND CULBERSON COUNTIES, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Base compiled from USGS Quadrangle sheets (Polyconic projection) and latest General Highway Maps
All planimetric features, latitude and longitude, and state coordinates taken from these sources.

5-71 4-R-30447
Rev. 5-71 4-R-29027

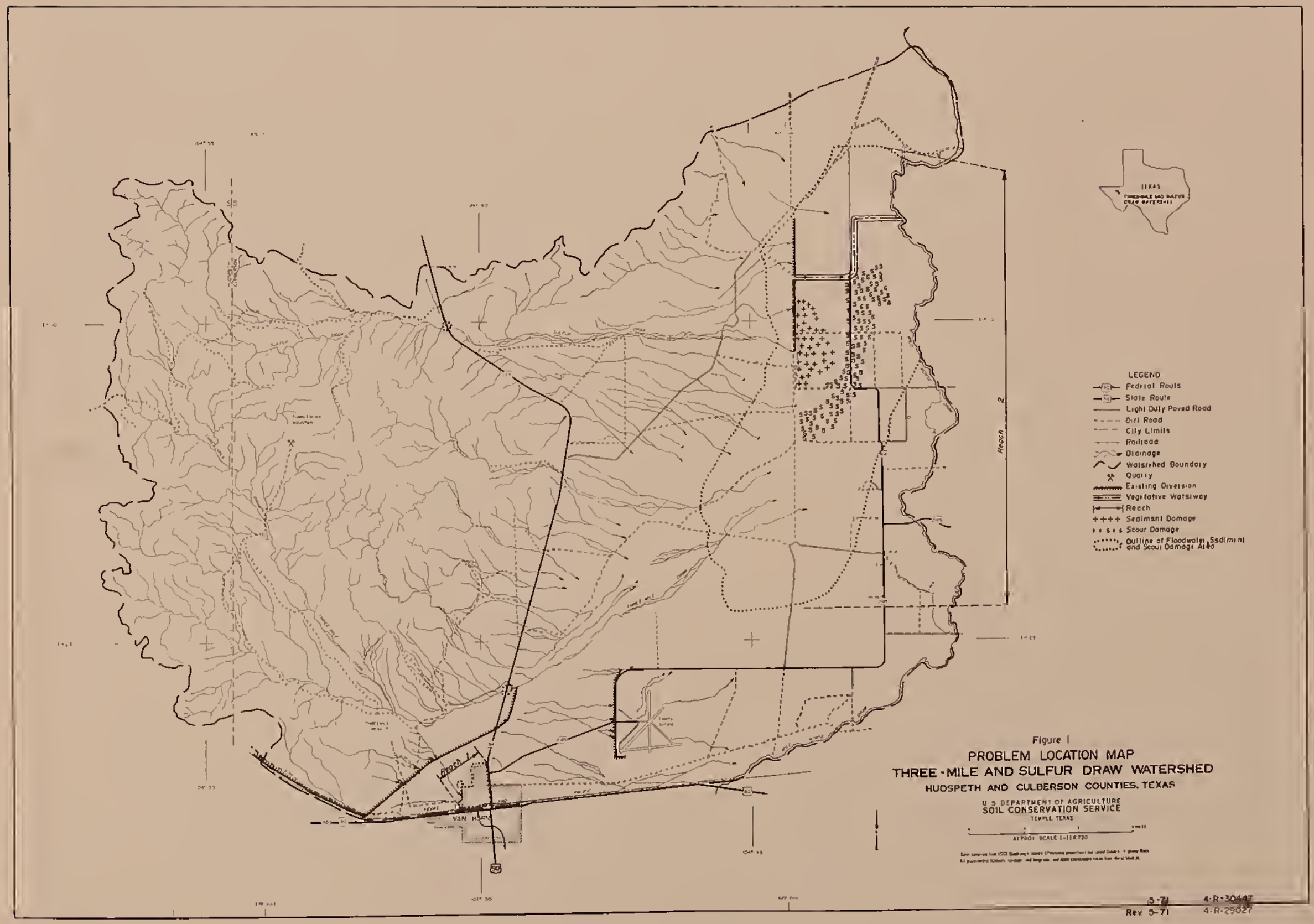


Figure 1

PROBLEM LOCATION MAP
THREE-MILE AND SULFUR DRAW WATERSHED
HUDSPETH AND CULBERSON COUNTIES, TEXAS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

AIRPORT SCALE 1:118,720

5-71 4-R-30147
Rev. 5-71 4-R-29027

USDA-SCS-FORT WORTH, TEX. 1971

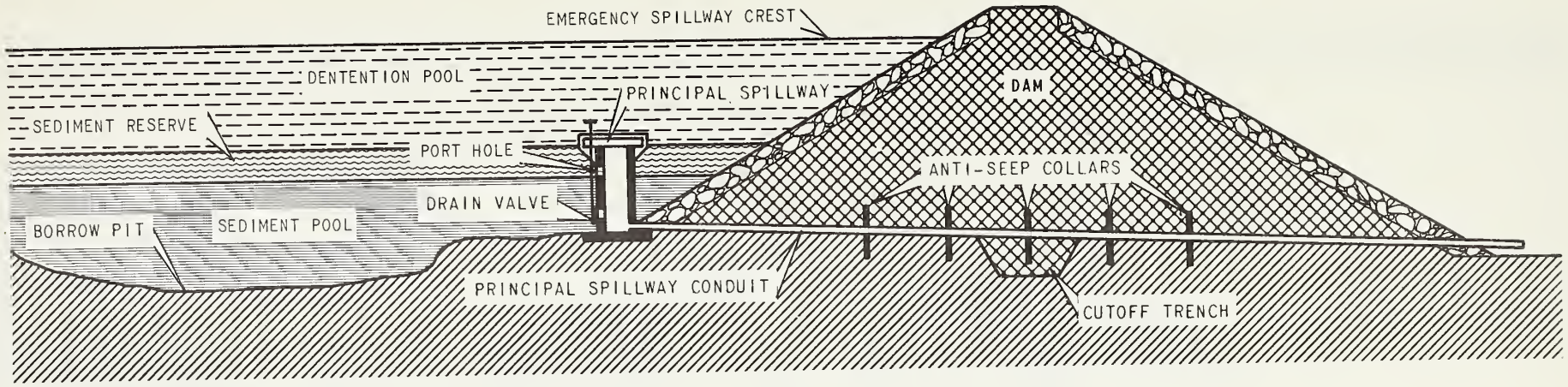
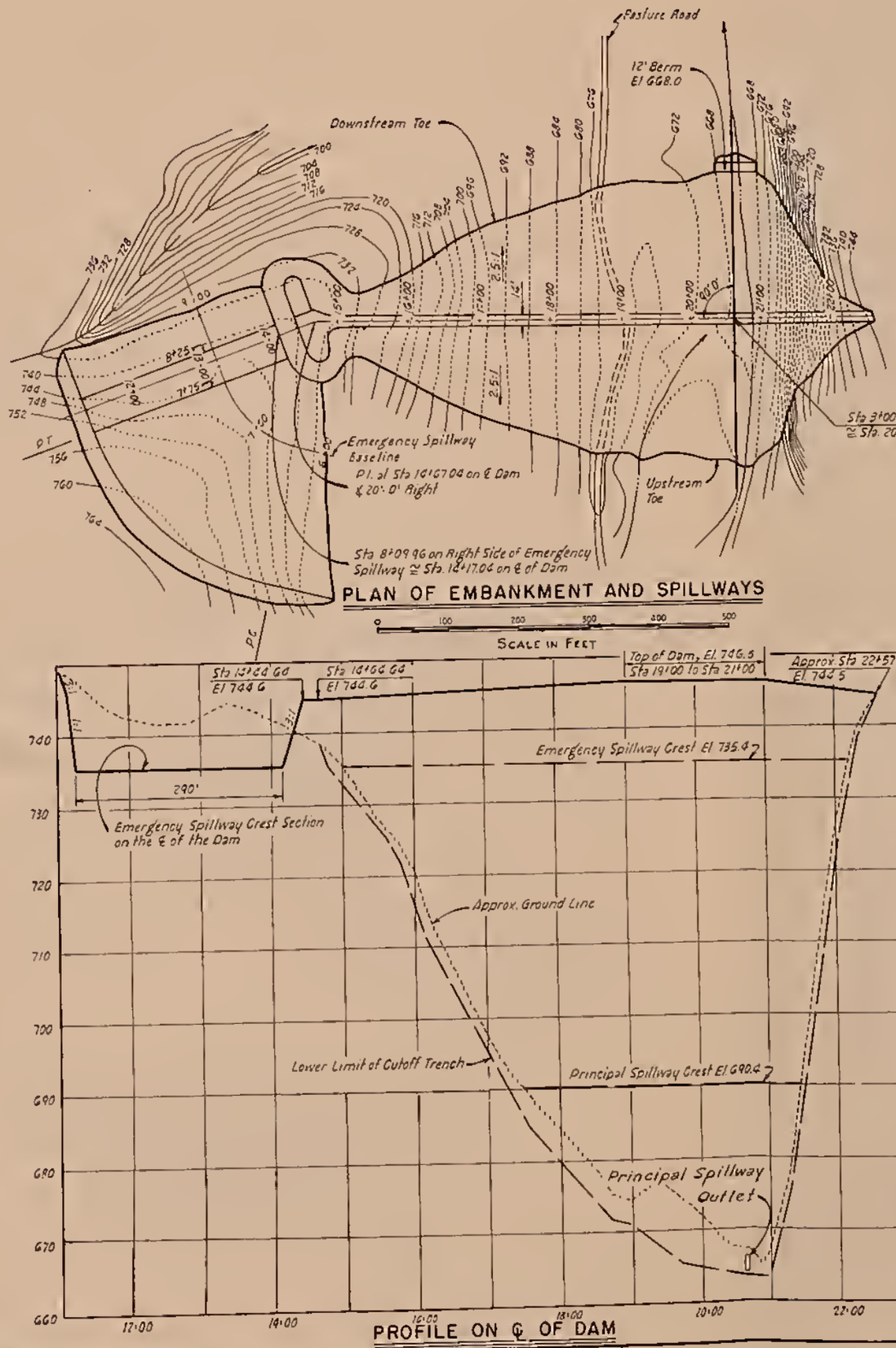


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

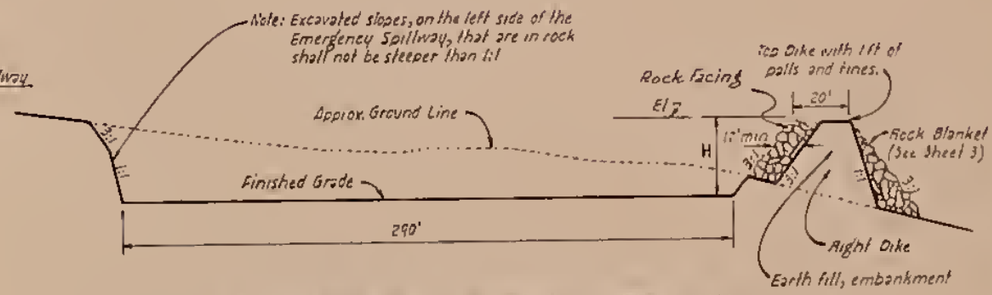
U. S. D. A., SOIL CONSERVATION SERVICE
USDA-SCS-FORT WORTH, TEX. 1971

6-71 4-L-10,071-E

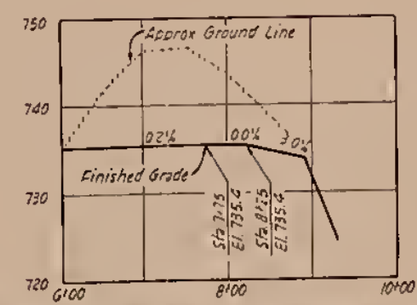


PLAN OF EMBANKMENT AND SPILLWAYS

PROFILE ON ℄ OF DAM



TYPICAL SECTION - EMERGENCY SPILLWAY



PROFILE ON BASELINE OF EMERGENCY SPILLWAY

Figure 3

**TYPICAL FLOODWATER RETARDING STRUCTURE
EMBANKMENT AND EMERGENCY SPILLWAY
PLAN AND PROFILE**

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Temple, Texas

REV. 4-74 4-E-21155-1

USDA-SCS-FORT WORTH, TEX. 1974

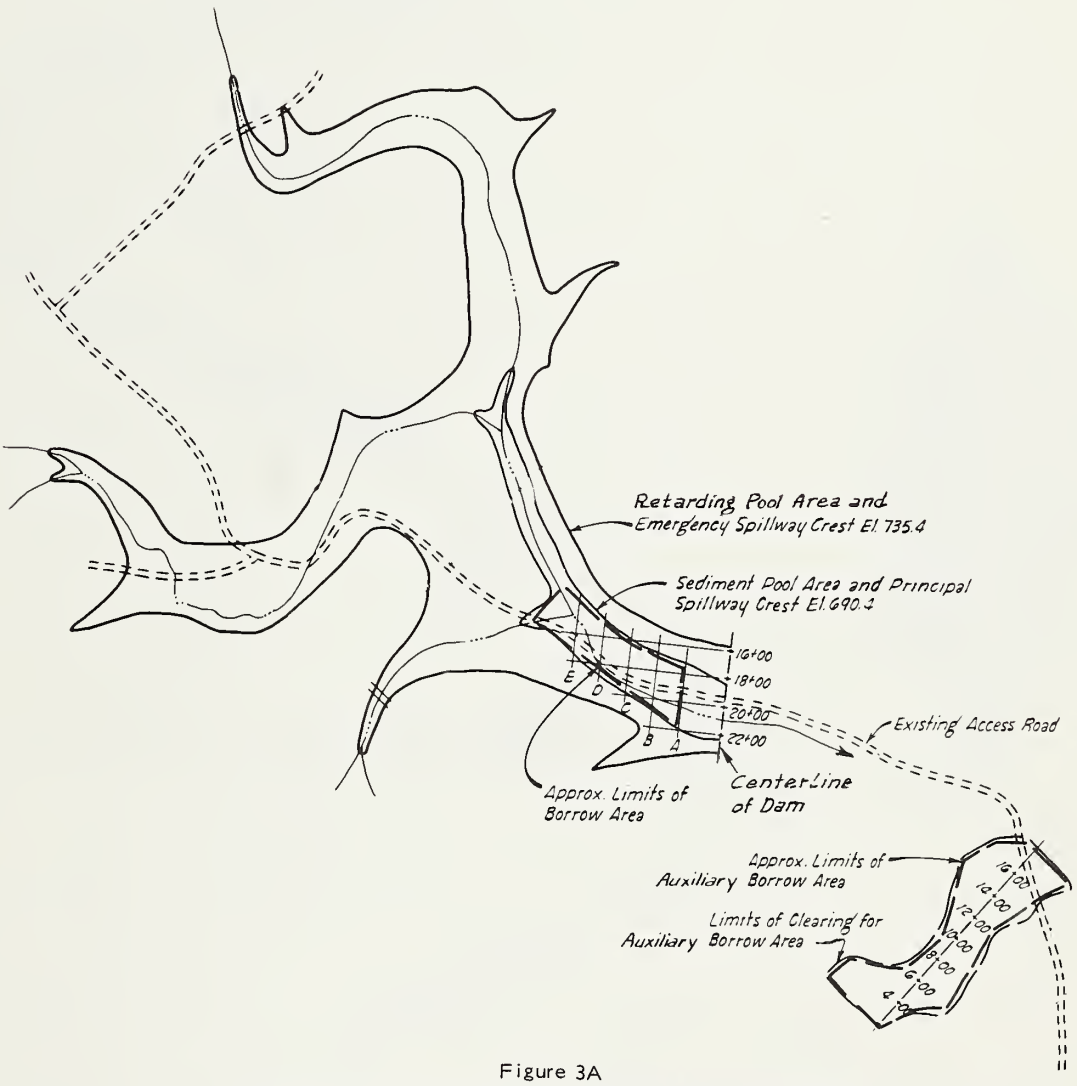


Figure 3A

TYPICAL FLOODWATER RETARDING STRUCTURE

GENERAL PLAN OF RETARDING POOL, SEDIMENT POOL AND BORROW AREAS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Temple, Texas

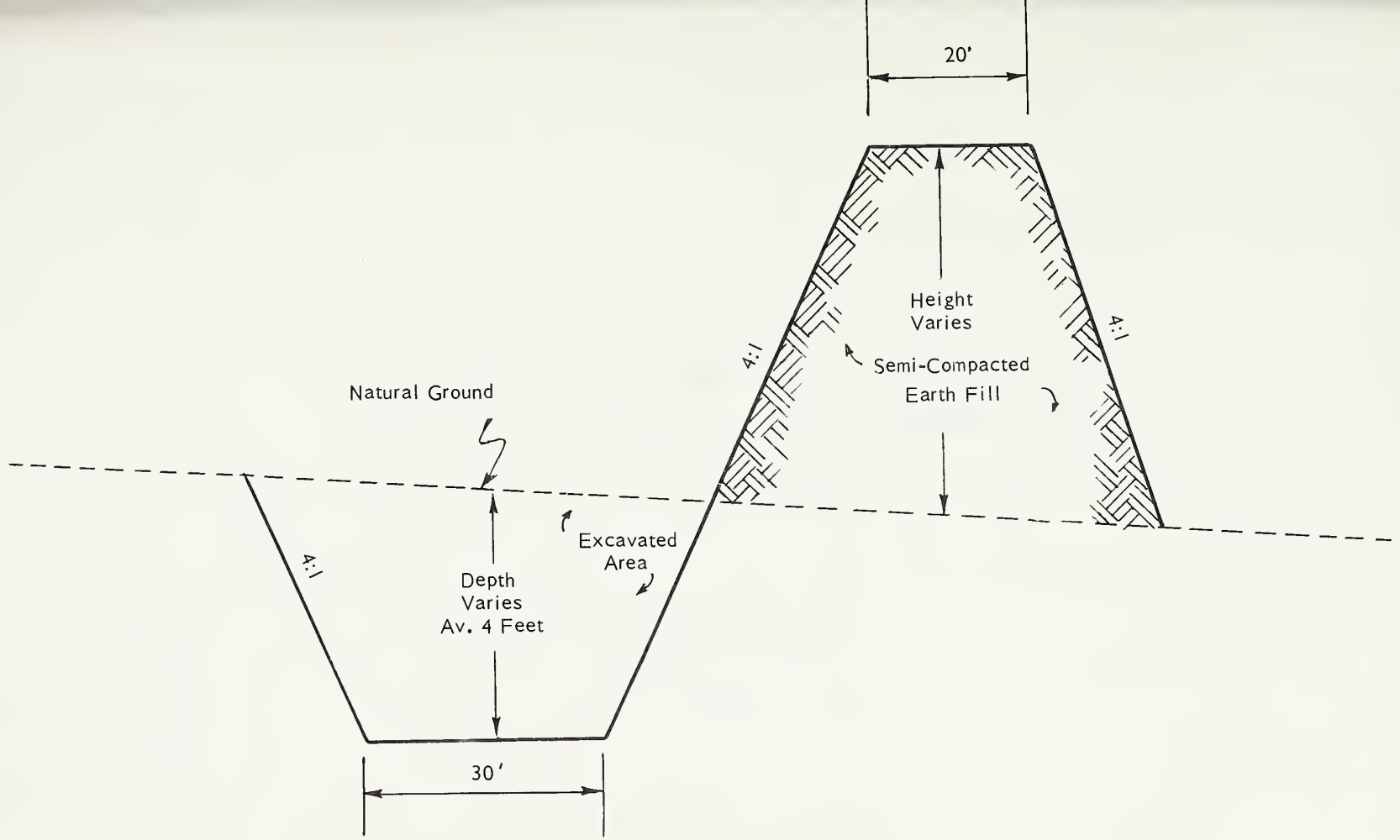


Figure 4

TYPICAL CROSS SECTION
FLOODWATER DIVERSION
THREE-MILE AND SULFUR DRAW WATERSHED
HUDSPETH AND CULBERSON COUNTIES, TEXAS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Temple, Texas

REV. 4-74 4-E-21155-3

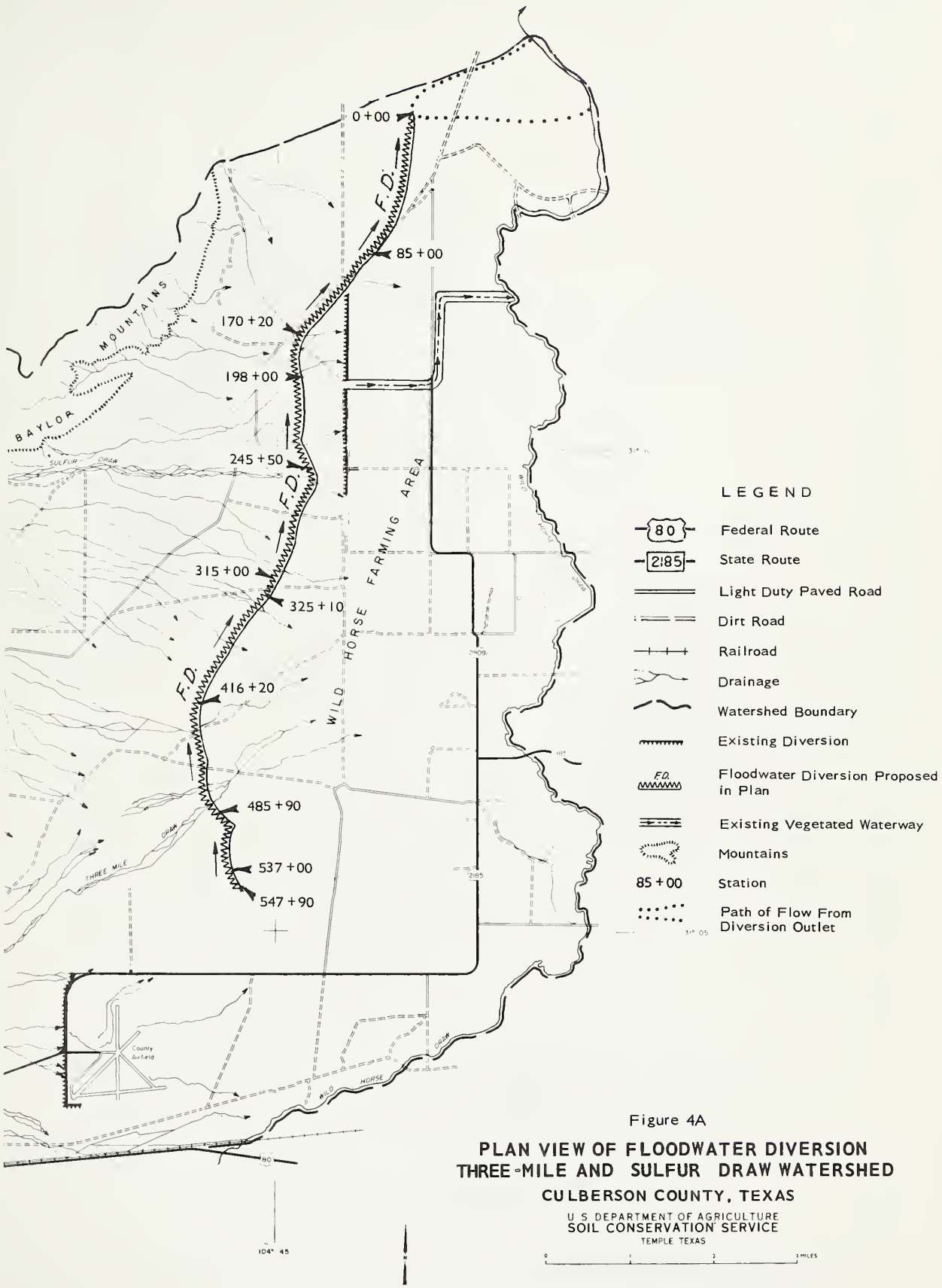


Figure 4A

PLAN VIEW OF FLOODWATER DIVERSION THREE-MILE AND SULFUR DRAW WATERSHED

CULBERSON COUNTY, TEXAS

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

0 1 2 3 MILES

Base compiled from USGS Quadrangle sheets (Polyconic projection) and latest General Highway Maps
All planimetric features, latitude and longitude, and state coordinates taken from these sources

REV. 10-74 4-E-21155-4

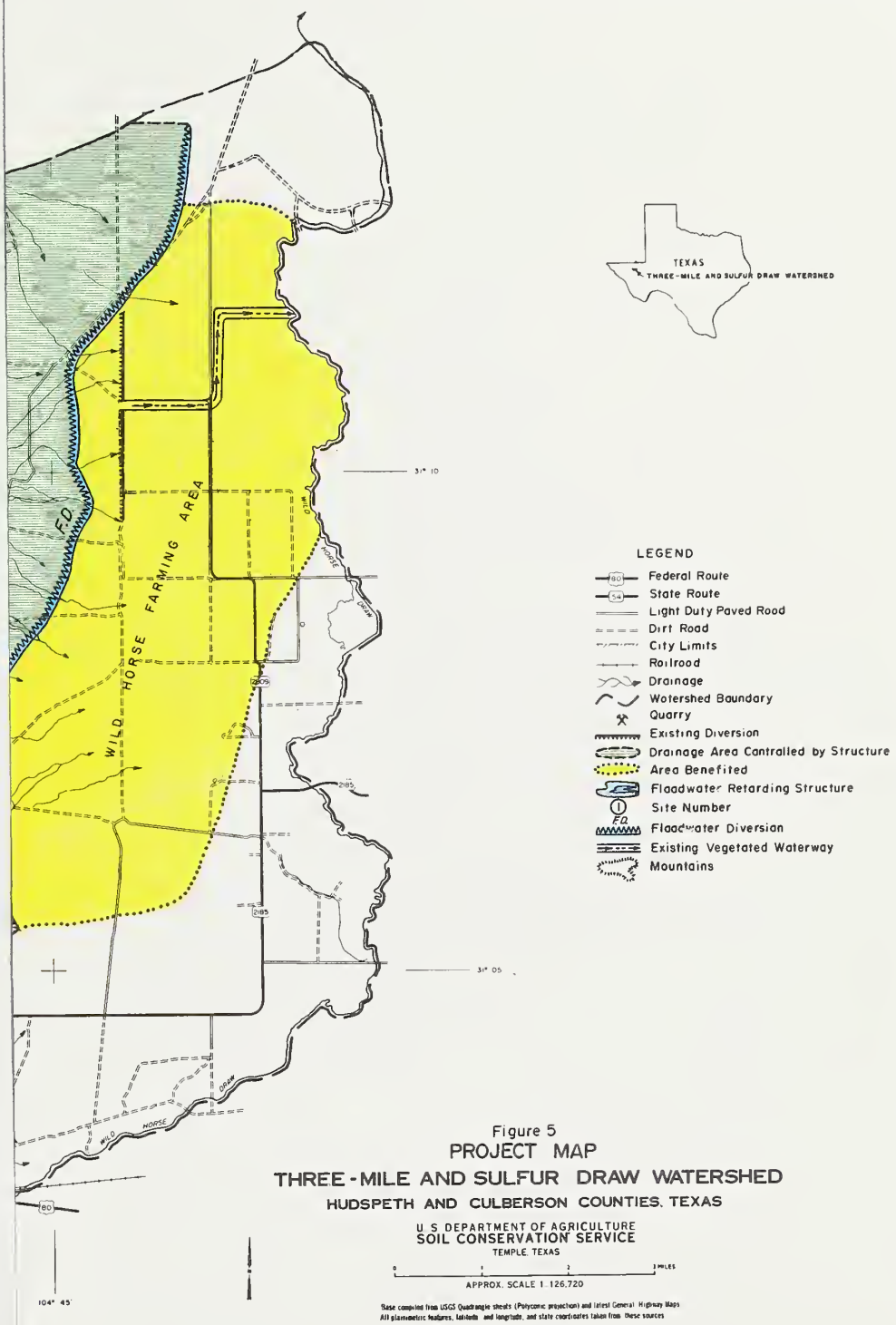


Figure 5

PROJECT MAP

THREE-MILE AND SULFUR DRAW WATERSHED

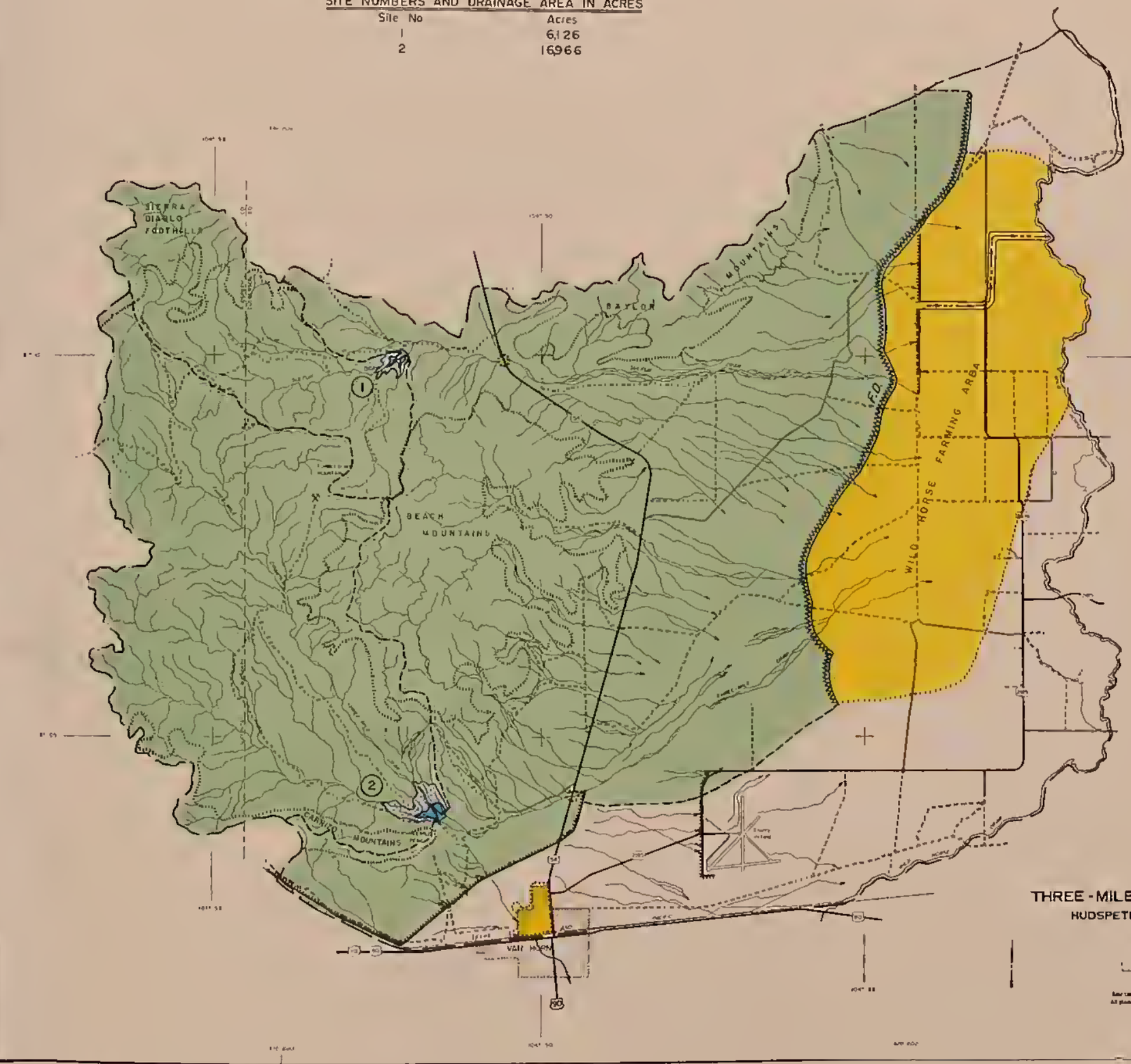
HUDSPETH AND CULBERSON COUNTIES, TEXAS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Revised December 1973 4-R-30448
Rev. 5-71 4-R-29027

SITE NUMBERS AND DRAINAGE AREA IN ACRES

Site No	Acres
1	6,126
2	16,966



LEGEND

- Federal Route
- State Route
- Light Duty Paved Road
- Dirt Road
- City Limit
- Railroad
- Drainage
- Watershed Boundary
- Quarry
- Existing Diversion
- Drainage Area Controlled by Structure
- Area Benefited
- Floodwater Retarding Structure
- Site Number
- Floodwater Diversion
- Existing Vegetated Waterway
- Mountains

Figure 5

PROJECT MAP

THREE-MILE AND SULFUR DRAW WATERSHED

HUDSPETH AND CULBERSON COUNTIES, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

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Revised December 1973 4-R-30448
Rev. 5-71 4-R-29027

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